A MANUAL
OF
ORGANIC MATERIA MEDICA
AND
PHARMACOGNOSY

AN INTRODUCTION TO THE STUDY OF THE VEGETABLE KINGDOM AND THE VEGETABLE AND ANIMAL DRUGS.

COMPRISING

THE BOTANICAL AND PHYSICAL CHARACTERISTICS, SOURCE, CONSTITUENTS, PHARMACOPŒIAL PREPARATIONS, INSECTS INJURIOUS TO DRUGS, AND PHARMACAL BOTANY.

BY

LUCIUS E. SAYRE, B.S., PH. M.,

DEAN OF THE SCHOOL OF PHARMACY; PROFESSOR OF MATERIA MEDICA AND PHARMACY IN THE UNIVERSITY OF KANSAS; MEMBER OF THE COMMITTEE OF REVISION OF THE UNITED STATES PHARMACOPŒIA.

THIRD EDITION, REVISED.

WITH

HISTOLOGY AND MICROTECHNIQUE

BY

WILLIAM C. STEVENS,

PROFESSOR OF BOTANY IN THE UNIVERSITY OF KANSAS.

WITH 377 ILLUSTRATIONS,

THE MAJORITY OF WHICH ARE FROM ORIGINAL DRAWINGS AND PHOTOMICROGRAPHS.

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PREFACE TO THE THIRD EDITION.

To the student and the instructor who are acquainted with the progress of pharmacy it is apparent that the publication of the eighth decennial revision of the United States Pharmacopœia demands a revision of all works bearing upon Materia Medica and Pharmacognosy. The decennial revision marks an important epoch in the history of pharmacy, and a general recognition of this is shown by the more or less prompt conformity to this latest standard of other works bearing upon it.

In the special line of Pharmacognosy there has been recently a vast deal of research, and a proper recognition of this demands a revision of works relating thereto. One branch of this—histology—has greatly increased our store of knowledge. This field alone has greatly added to the labor of preparing the manuscript of the present edition. In connection with this part of the work the author desires to express his indebtedness to Mr. Chas. Sterling and Mr. L. D. Havenhill; through the co-operation of these associates in the University it has been made possible for the author to present such additions to the work as the microscopical elements of vegetable powders and to furnish photo-micrographs of various drug sections. The author desires to give these associates the entire credit for this work. It has been necessary to review the whole field of Materia Medica in order to add the new and useful drugs, assayed drugs and preparations, plant constituents and active principles, and to eliminate those which no longer serve the student or the instructor representing this extensive subject.

To the chapter on organic chemicals has been added a large number of modern synthetic remedies. The aim has been to present those remedies actually prescribed by physicians and dispensed by pharmacists. This could be accomplished only by compiling such a list from recent prescription files and from orders from wholesale and jobbing houses. The author is much indebted for help in this direction to Mr. H. D. Faxon, with Faxon, Horton and Galligher, of Kansas City, Mo.

The present edition aims to give the present facts regarding Materia Medica and Pharmacognosy in as concise a form as possible. Many of the former articles have been reduced in length in order to prevent undue

enlargement of the volume necessarily occasioned by the added new material.

For the first time in its history the pharmacopœia names a dose for each of the various official agents—the *average* dose of each drug and preparation is given. It should be stated, in this connection, that the author, in this revision, has not conformed to this method, but has continued the plan, of former editions, of stating the *maximum* and *minimum* doses recognized by authorities on posology.

With a few exceptions there has been added to the description of all of the official drugs a brief statement as to the prominent characteristic microscopical elements found in their powders. Chapter XI of Part IV, on Powdered Drugs, has been rewritten and extended in order to present the facts, which are of growing importance to pharmacy students and instructors, in such a manner as to command attention to this very interesting subject.

L. E. S.

University of Kansas.

PREFACE TO THE SECOND EDITION.

In preparing the second edition it has been the aim to enhance the value of the book to the practical pharmacist. With this end in view the chapters on Elementary Botany have been replaced by Part IV, on Histology and Microtechnic. The value of skill in the use of the microscope, and of a knowledge of the minute anatomy of plant structures, is becoming more fully recognized as the science of Pharmacy advances. Pharmacognosy is destined to make notable progress along with the development of microchemical technic. The dependence of Pharmacognosy on microchemical methods has been recognized by the considerable space devoted to the chapters on Reagents and Processes, and Plant Products. In the chapters on Histology the development and functions of tissues are discussed not because it is supposed that histogeny and physiology have an immediate application in Pharmacognosy, but for the reason that there can be no comprehensive knowledge of anatomy without the broader view which histogeny and physiology afford.

The chapter on Organic Synthetical Remedies has been replaced by a more condensed treatment embracing a classification of these agents.

In appending to the more potent drugs the notes on the active principles, usually alkaloids, the idea has been to show principles of separation rather than the details of practical operation, and to this end only a brief outline of a simple method of isolation is given. Some of the more important characteristics of the principles are also given. Although over 150 pages of new material appear in this edition, and as many new illustrations, the size of the volume has not been materially increased.

Acknowledgment is here made to Dr. Edward Bartow, of the University of Kansas, for valuable services in the preparation of the Classification of Organic Synthetical Remedies.

PREFACE TO THE FIRST EDITION.

The present volume is, in a slight degree, a revision of a work written by the author in 1879, entitled "Organic Materia Medica and Pharmacal Botany." This work has been out of print a number of years, and until recently the author has had no time to rewrite it in such a manner as seemed necessary to bring it up to the present standard; it has also been deemed advisable to change completely the model of the former work. The task now accomplished presents not so much a revision, as a new treatise.

Two methods of classification of drugs are here brought into use—a classification according to physical characteristics, and a classification according to botanical relationships,—both of which are, though occupying separate divisions of the book, so brought together by a system of numbering that the place of the drug in each of the classes is at once apparent. The author would here suggest that those who make use of the work in connection with a cabinet of specimens, should have the containers in the cabinet numbered to accord with the numbers in the book, in order that students may readily find specimens for identification and study.

It is perhaps needless to state that the nomenclature and general character of the text is made to conform with the present standard—the United States Pharmacopœia; but the capitalization of specific names derived from proper nouns has been discarded, in accordance with present botanical practice. The descriptive heading of each of the official drugs has been in most cases given in the pharmacopœial language. The unofficial drugs are distinguished in the text by the use of a different type and by a different setting of the article from that which treats of the official drugs. In this connection the author desires to give credit to Mr. George S. Davis, who has aided in the work by placing at the author's disposal most excellent material regarding rare unofficial drugs, and the use of material from his publication, credited under Bibliography.

The scope of the work, it will be seen, embraces not only the official drugs of the vegetable and animal kingdoms, but a vast variety of unofficial drugs, some of which are of rare occurrence in the market. These have been included because of the greater field this inclusion gives for

pharmacal and botanical study; the greater variety of forms presented to the student of pharmacognosy, the wider will be his range of observation. It is hoped that in the 624 drugs mentioned, the student or instructor will be able to make a selection which will be ample to supply material to illustrate the principles of the subject under consideration. In a work of this size an exhaustive treatment of this number of drugs could not be given, but by a brief mention of them material for study is indicated. It may be mentioned in this connection that wherever metric measurements are given, these are stated in millimeters; this has been deemed advisable for the purpose of comparison.

The illustrations included in Part I are taken mainly from Bentley's "Manual of Botany," to the author of which our thanks are due. An exception, however, is found in the drawings of the starches, which were prepared from original specimens. The remaining illustrations, with the exception of those in the Chapter on Animal Drugs, have been prepared under the direction of C. E. McClung, Ph. G., a graduate of the Kansas State University School of Pharmacy, class of '92. All the drawings of the cross-sections are drawn directly from sections prepared by him, the cell contents being first removed by the method described in Appendix C. It has been our aim to present the elements of each drug in their true proportions. As often as possible the cells in their exact shape and relative size have been drawn, and in no case has meaningless shading been employed. For some of the drawings of the medicinal plants credit is given below in the Bibliography. The illustrator has kindly furnished a Chapter on Pharmacal Microscopy, which will be found in Appendix C.

The author is much indebted to Professor Vernon Kellogg for information concerning animal drugs used in pharmacy; also for Appendix B, in which he treats of insects attacking drugs. The drawings to illustrate the material furnished by Professor Kellogg are hereby credited to Miss Mary Wellman, artist.

For aid in the preparation of the text in Part I our thanks are due to Mr. A. O. Garrett, who, in his university course, has made botany a special study.

Appendix B, upon the synthetic remedies, is the work of Mr. F. B. Dains, who has made a specialty of organic chemistry and was instructor in this subject in the University of Kansas during the year 1894. In this section the new spelling of chemicals has been adopted only in a few cases.

To Dr. S. W. Williston, Professor of Physiology and Anatomy, who has aided in the condensed description of therapeutic action; to Mr. O. H. Parker and Mr. William Clark, members of the Senior Class of '94, who assisted in the study of characteristics from crude specimens of drugs

in the open market; to Mr. W. O. Strother, of the same class, who supplied a few drawings of cross-sections; and to Mr. W. F. Newton, of the Junior Class, who materially aided not only in the study of drug characteristics, but also in arranging the material, our thanks are due.

L. E. S.

BIBLIOGRAPHY.

The following works have been consulted, and credit is due to the authors of the same:

United States Pharmacopœia.
United States Dispensatory.
National Dispensatory.
" Reports of the American Pharmaceutical Association."
Friederich A. Flückiger and Daniel Hanbury: "Pharmacographia," London, 1874.
John Harley: "Royle's Materia Medica," sixth edition, London, 1876.
John M. Maisch: "A Manual of Organic Materia Medica," Philadelphia, 1892.
Parke, Davis & Co.: "Organic Materia Medica," Detroit, 1888.
Robert Bentley: "A Manual of Botany," London, 1887.
John B. Shoemaker: "Materia Medica and Therapeutics" (2 vols.), Philadelphia, 1893.
Samuel O. L. Potter: "Materia Medica, Pharmacy, and Therapeutics," fifth edition, Philadelphia, 1894.
W. H. White and Reynoldds W. Wilcox: "Materia Medica and Therapeutics," second edition, Philadelphia, 1894.
Asa Gray: "Manual of the Botany of the Northern United States," New York, 1889.
Alphonso Wood: "Class Book of Botany," New York, 1866.
William Dymock, C. J. H. Warden, David Hooper: "Pharmacographia Indica," London and Bombay, 1893.
Bernard Fischer: "Die Neueren Arzneimittel" (sixth edition), Berlin, 1894.
A. Brestowski: "Die Neueren und Neuesten Arzneimittel," Leipzig, 1891.
Lehn & Fink: "Notes on New Remedies," New York.
David M. R. Culbreth: "Materia Medica and Pharmacology," Philadelphia, 1896.

Also, the following works, from which, in addition, illustrations have been taken:

Kohler's "Medizinal-Pflanzen," Hrs'g von G. Pabst (2 vols.), 1887–1890.
Robert Bentley and Henry Trimen: "Medicinal Plants" (4 vols.), London, 1880.
Charles E. Bessey: "Botany," fifth edition, 1888.
A. B. Frank: "Lehrbuch der Botanik," Leipzig, 1892.
Emm. Le Maut and Th. Decaisne: "Traité Général de Botanique," Paris, 1876.
Anton Kerner von Marilau: "Pflanzenleben" (2 vols.), Leipzig, 1887.
J. Godfrin, De Nancy, et Ch. Noël: "Atlas manuel de l'histologie de drogues simples," Paris, 1887.
L. Trabut: "Précis de Botanique Médicinale," 1891.
Friederich A. Flückiger and Alexander Tschirch: "The Principles of Pharmacognosy," New York, 1887; Translated by Friederich B. Power.

William Woodville: "Medical Botany" (second edition), London, 1810.
Eduard Strasburger: "Das Botanische Practicum," Jena, 1897.
Naegeli and Schwendener: "The Microscope," Swan, Sonnenschein & Co., London, 1892.
Eduard Strasburger: "Bau und Verrichtungen der Leitungsbahnen in den Pflanzen," Jena, 1891.
Sachs: "Text Book of Botany."
De Bary: "Comparative Anatomy of Phanerogams and Ferns," Oxford, 1884.
Haberlandt: "Physiologische Pflanzenanatomie," Leipzig, 1896.
Pfeffer: "Pflanzenphysiologie," Leipzig, 1897.
Meyer: "Untersuchungen über die Stärkekörner," Jena, 1895.
Thomas and Dudley: "Laboratory Manual of Plant Histology," Crawfordsville, Ind., 1894.
Vines: "Student's Text Book of Botany," London and New York, 1895.
Strasburger: "Cytologische Studien," Berlin, 1897.
Beilstein: "Handbuch der Organischen Chemie," Hamburg und Leipzig, 1898.
Strasburger, Noll, Schenck, Schimper: "Lehrbuch der Botanik," Jena, 1894.
Zimmerman, A.: "Botanical Microtechnique," New York, 1893.
Tschirch and Oesterle: "Anatomischer Atlas der Pharmakognosie und Nahrungsmittelkunde," Leipzig, 1900.
Dr. A. E. Vogl: "Die Wichtigsten Vegetabilishen Nahrungs und Genussmittel," Berlin and Wien, 1899.
Dr. Albert Schneider: "Powdered Vegetable Drugs," Pittsburg, 1902.
Dr. Henry Kreamer: "Botany and Pharmacognosy," Philadelphia, 1902.
Henry George Greenish, F. I. C., F. L. S.: "Foods and Drugs," Philadelphia, 1903.
Dr. George Karsten: "Lehrbuch der Pharmakognosie des Pflanzenreiches," Jena, 1903.
Dr. Arthur Meyer: "Die Grundlagen und die Methoden für die Mikroskopische Unterendung von Pflanzenpulver," Jena, 1901.
Dr. Ludwig Koch: "Die Mikroskopische Analyse der Droguenpulver," Berlin, 1904.
Greenish and Collin: An Anatomical Atlas of Vegetable Powders," London, 1904.
White and Humphrey : "Pharmacopedia," London, 1904.

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ORGANIC MATERIA MEDICA

AND

PHARMACOGNOSY.

PART I.

A STUDY OF DRUGS.

CLASSIFICATION.

Drugs may be arranged in several different ways, to suit the aim and convenience of the student. The prominent systems of classification in common use are as follows:

I. **Therapeutical.**—This system of classification is especially valuable to the student of medicine. Here the physiological action and therapeutical application are made most prominent.

II. **Chemical.**—Classification of organic drugs is not infrequently based upon the character of the constituents. In this way alkaloidal drugs, glucosidal drugs, drugs containing volatile oil, etc., form the subgroups. Other subgroups of chemical classification are:

Inorganic Chemicals.—To the pharmacist the chemical action, the crystalline form, the solubility, and other physical properties are of especial value. For mineral substances, therefore, he adopts the classification of the chemist. Some therapeutists, seeing a certain relation between therapeutical action and chemical constitution, adopt the same method of grouping also for these mineral substances.

Synthetical Remedies.—This class of remedial agents is most difficult to classify in a manner consistent with science, partly because our materia medica is becoming overloaded with proprietary combinations and mix-

tures of synthetic medicinal products with various adjuvants to modify their action. These latter have oftentimes certain unscientific names, which give little or no idea of their composition.

III. **Physical.**—According to this method, drugs having allied physical properties are brought together. Roots, leaves, flowers, fruits, and seeds form the principal divisions. Under this head two different arrangements are presented in this volume: (*a*) Classification into subgroups based upon such prominent features as odor, taste, etc. By this means the aromatic, bitter, acrid, sweet, and mucilaginous drugs are brought together. (*b*) Classification into subgroups based upon structural characteristics. Here drugs having similar structure are found associated. In the table having this arrangement the official drugs only are found. Appended to each there is a physical description in the fewest possible terms—such prominent terms as are used in describing the physical and structural characteristics.

Each drug has a number, so that a ready reference to the same drug in the body of the work is made easy. Here a fuller description is found.

Instructors in pharmacognosy who use this book are recommended to employ this conspectus and to have the students use these numbers. When labeling the drug (or its container) for class work, these numbers should be employed. The experience of the author in teaching the subject under consideration has been most favorable to this method. By the use of the numbers at first, the student quickly grows to learn, not only the drug, but the place in the system to which it belongs. The subject grows in interest until he is able to recognize the drug and to properly classify it.

IV. **Botanical.**—By this arrangement drugs belonging to the same natural order are brought together. In subdividing these orders botanical relationship is emphasized to as large an extent as is practicable in dealing with drugs from a pharmaceutical standpoint. From the point of view of the scientist this is the ideal system. This method has been adopted in the body of this work.

Geographical.—Drugs are rarely classified according to the locality of their occurrence. It is, however, instructive to the student to refer individual or classes of drugs to their locality. Drugs of ancient times were obtained chiefly from Asia. Many of these have survived, and are official to-day; notably aloes, myrrh, etc. With the discovery of the new world many important drugs were made accessible. Geographical classification is therefore of interest from many points of view. The presentation of this subject is facilitated by outline maps with the drugs indicated in their natural localities. As an example of such a map, see Cinchona.

Alphabetical Arrangement.—In all the standard books of reference, such as the "Pharmacopœia" and the "Dispensatories," a strictly alphabetical arrangement is followed, no attention being paid to systems of classification. The arrangement is made wholly subservient to quick and ready reference.

In the following order four classifications will be presented: 1. A synopsis of therapeutical agents. 2. Chemical agents. 3. Classification of

organic drugs, as indicated under (*a*) and (*b*). 4. Botanical arrangement, where drugs will be treated at some length.

TABLE OF THERAPEUTICAL AGENTS.

I. INTERNAL REMEDIES.

A. *Affecting Nutrition:*
- Hæmatics (Blood Tonics).
- Alkalies.
- Acids.
- Digestants.
- Antipyretics.
- Alteratives.

B. *Affecting the Nervous and Muscular Systems:*
- (*a*) The Brain—
  - Cerebral Excitants.
  - Cerebral Depressants.
  - Narcotics.
  - Hypnotics.
  - Analgesics.
  - Anæsthetics.
- (*b*) The Spinal Cord—
  - Motor Excitants.
  - Motor Depressants.
- (*c*) Nerve Centers and Ganglionic System—
  - Antispasmodics.
  - Tonics.
  - Antiperiodics.
- (*d*) Heart and Circulatory System—
  - Cardiac Stimulants.
  - Cardiac Sedatives.
  - Vascular Stimulants.
  - Vascular Sedatives.
- (*e*) Excretories—
  - Diuretics.
  - Renal Depressants.
  - Vesical Tonics and Sedatives.
  - Urinary Sedatives.
  - Diaphoretics and Sudorifics.
  - Anhidrotics.
  - Antilithics.

C. *Affecting Special Organs—Partly Through the Nervous System:*
- (*a*) Organs of Respiration—
  - Expectorants.
  - Pulmonary Sedatives.
  - Errhines.
  - Sternutatories.
- (*b*) Alimentary Canal—
  - Sialagogues.
  - Emetics.
  - Purgatives.
  - Astringents.
  - Stomachics.
- (*c*) The Liver—
  - Hepatic Stimulants.
  - Cholagogues.
  - Hepatic Depressants.

(*d*) Generative System—
Ecbolics or Oxytocics.
Emmenagogues.
Aphrodisiacs.
Anaphrodisiacs.

(*e*) Eyes (Ciliary Muscle)—
Mydriatics.
Myotics.

II. EXTERNAL REMEDIES.

A. *Irritants:*
Rubefacients.
Epispastics.
Pustulants.
Escharotics.

B. *Local Sedatives:*
Demulcents.
Emollients.

III. AGENTS WHICH ACT UPON ORGANISMS WHICH INFEST THE HUMAN BODY.

Antiseptics
Disinfectants.
Antizymotics.
Anthelmintics.
Antiparasitics.
Antiperiodics.

THERAPEUTICAL AGENTS DEFINED.

HÆMATICS restore the quality of the blood to normal condition. They exert a direct influence on the composition of the blood: *e. g.*, preparations of iron, of manganese, cod-liver oil, etc.

ALKALIES act, in the concentrated form, as caustics (escharotics), but when diluted, as antacids. Dilute alkalies, if given before meals, however, will stimulate the production of the acid gastric juice. The carbonates of potassa and soda and the bicarbonates, also preparations of the alkaline earths, such as lime-water and mixtures of magnesium carbonate, are good examples. Some of the salts of the alkalies have a remote antacid effect, becoming decomposed in the blood and excreted in the urine, which they render less acid.

ACIDS.—These have an action opposite to that of the alkalies. When much diluted, they are administered for the purpose of checking hyperacidity of the stomach, by stimulating the production of the alkaline pancreatic juice and checking the acid gastric juice.

DIGESTANTS.—Agents which effect solution (digestion) of food in the alimentary canal. Examples: Pepsin, pancreatin, trypsin, papain, etc.

ANTIPYRETICS.—Agents which reduce the temperature of the body, either by reducing the circulation or diminishing tissue change, or favor-

ing the loss of heat through radiation, conduction, etc. Examples: Quinine, aconite, antipyrine, antimony, etc.

ALTERATIVES.—A term used to designate a class of agents which alter the course of morbid conditions, modifying the nutritive processes while promoting waste, by stimulating secretion, absorption, and the elimination of morbid deposits; especially used in the chronic diseases of the skin. Employed in the treatment of phthisis, syphilis, gout, neuralgia, asthma, etc. Examples: Arsenious acid, mercury, iodine and the iodides, sarsaparilla, guaiac, colchicum, stillingia, etc.

CEREBRAL EXCITANTS.—Agents which increase the functional activity of the cerebrum, without causing any subsequent depression of brain function. Examples: Camphor, valerian, caffeine, cannabis (in small doses), etc.

CEREBRAL DEPRESSANTS have an opposite effect to the preceding, lessening brain activity. Some of the drugs of this class are employed as hypnotics or as analgesics.

NARCOTICS.—Agents which lessen the sensibility to pain and cause sleep. A narcotic will abolish pain, while an anodyne will frequently merely overcome wakefulness. Examples: Opium, cannabis indica, belladonna, humulus, etc.

HYPNOTICS.—Agents which induce sleep and will often abolish pain and cause neither deliriant nor narcotic effects. Examples: chloral, sulphonal, trional, the bromides, etc.

ANALGESICS.—Agents which relieve pain by their effect upon the sensory centers; the term is synonymous with anodynes. The general anodynes, when taken internally, affect the whole organism; local anodynes affect the part to which they are applied, some by their depression of the terminal nerve organs in the skin, others by reducing the local circulation. Examples: Opium, belladonna, hyoscyamus, aconite, antipyrine, acetanilid, etc.

ANÆSTHETICS.—Agents which suspend consciousness and temporarily destroy sensation. The local anæsthetics affect only the part to which they are applied, and diminish or temporarily destroy the sensibility of the part. Examples: Ether, chloroform, nitrous oxide, etc. Local anæsthetics: Cocaine, carbolic acid, ether spray, etc.

MOTOR EXCITANTS.—Agents which increase the functional activity of the spinal cord and the motor apparatus, invigorating the action of the heart and lungs. Examples: Nux vomica, strychnine, etc.

MOTOR DEPRESSANTS have an opposite effect to the motor excitants, lowering the functional activity of the spinal cord and motor apparatus. Examples: Alcohol, opium, aconite, conium, belladonna, etc.

ANTISPASMODICS.—Agents acting on the nervous system in various

ways. They prevent or allay irregular action or spasm of voluntary and involuntary muscles. This is accomplished frequently by a sedative influence upon the nerve centers, while a few others exert their influence by stimulating the nerve centers. Examples: Alcohol, ether, valerian, camphor, asafœtida, musk, the bromides, hydrocyanic acid, etc.

Tonics.—Agents which increase the vigor and tone of the system by improving the appetite, favoring digestion and assimilation, and adding strength to the circulatory system. Examples: Gentian, columbo, quinine, etc.

Antiperiodics.—Agents which prevent or check the return of diseases which recur periodically, possibly by a toxic action upon the microbes in the blood, which are supposed to cause the disease; but little is known of their mode of action. The typical antiperiodic, quinine, has, however, a decided effect upon the heart and brain, as well as other parts of the nervous system.

Cardiac Stimulants, as the name implies, are agents which increase the heart's action, the force and frequency of the pulse. Examples: Ether, alcohol, atropine, sparteine, nitroglycerine, etc.

Cardiac Sedatives allay and control palpitation and overaction of the heart. Examples: Aconite, veratrum viride, digitalis, antimony, etc.

Vascular Stimulants.—Agents which dilate the peripheral vessels and increase the peripheral circulation. Members of this class also strengthen the heart's action, and are advantageously employed in debilitated conditions of the central organs of the circulation. Examples: Alcohol, preparations of ammonia, caffeine, digitalis, strophanthus, etc.

Vascular Sedatives.—Agents which lessen the capillary circulation and raise the blood pressure by stimulating the vasomotor center or its mechanism and the walls of the vessels. Examples: Ergot, digitalis, opium, salts of iron, etc.

Diuretics.—Agents which increase the secretion of urine, acting either directly upon the secreting cells of the kidneys or by raising the general or local arterial tension. Employed in acute congestion and inflammation of the kidneys and in dropsies. Examples: Squill, scoparius, triticum, and organic salts of the alkalies.

Renal Depressants.—Agents which lower the activity of the renal cells, thereby lessening the urinary secretion. Examples: Morphine, quinine, ergot, etc.

Vesical Tonics and Sedatives.—Agents acting upon the bladder, in the one case increasing the tone of the muscular fibers and in the other lessening the irritability of that organ. Examples: Tonics—strychnine, cantharis, belladonna, etc.; sedatives—opium, buchu, uva ursi, pareira, etc.

RENAL SEDATIVES.—Agents which exert a sedative action upon the whole urinary tract. Examples: Copaiba, cubebs, etc.

DIAPHORETICS AND SUDORIFICS.—Agents which increase the action of the skin and promote perspiration. Examples: Dover's powder, jaborandi, camphor, sweet spirits of niter, etc.

ANHIDROTICS.—Agents which check perspiration. Examples: Acid camphoric, atropine, zinc salts, acids, etc.

ANTILITHICS.—Agents used to prevent the formation of insoluble concretions or to dissolve concretions when formed in the ducts. Examples: Salts of lithia, potassium, benzoic acid, etc.

EXPECTORANTS.—Agents which are employed to facilitate the expulsion of bronchial secretions and to modify the character of these when abnormal. Examples: Ammonium chloride, the aromatic balsams, squill, licorice, senega, etc.

PULMONARY SEDATIVES.—Agents which allay the irritability of the respiratory center and the nerves of the lungs and bronchial tubes. Examples: Belladonna, opium, hyoscyamus, hydrocyanic acid, etc.

ERRHINES AND STERNUTATORIES are agents which affect locally the nasal mucous membrane, producing sneezing and an increase of nasal secretion. They also indirectly stimulate the vasomotor centers and at the same time excite the respiratory centers. Examples: Ipecacuanha, sanguinaria, veratrine, etc.

SIALAGOGUES.—Agents which promote the secretion and flow of saliva from the salivary glands. Examples: Pyrethrum, mezereum, the mercurials and antimonials, etc.

EMETICS.—Agents which cause vomiting, acting directly upon the nerves of the stomach or acting through the blood upon the vomiting center, or by reflex irritation of the vomiting center. Examples: Mustard, zinc sulphate, apomorphine, ipecacuanha, tartar emetic, etc.

PURGATIVES produce evacuation of the contents of the intestinal canal by increasing secretion along the tract, by exciting peristaltic action, etc. Examples: Podophyllum, colocynth, jalap, croton oil, magnesium sulphate, etc.

ASTRINGENTS.—Agents which produce contraction of muscular fiber, which coagulate albumen and lessen secretion from mucous membranes. Examples: Tannic and gallic acids, alum, lead acetate, persulphate of iron, etc.

STOMACHICS.—Agents which increase the appetite and promote gastric digestion. They also check fermentation and dispel accumulation of flatus. Examples: Peppermint, cardamom, ginger, capsicum, etc.

HEPATIC STIMULANTS (Cholagogues).—Agents which excite the liver and increase the functional activity of that organ so that the amount of

bile is augmented, etc. Hepatic stimulants increase the activity of the liver-cells, while cholagogues remove the bile from the duodenum. Examples: Podophyllum, aloes, jalap, colocynth, mercurous chloride, etc.

Hepatic Depressants.—Agents which reduce the functional activity of the liver, having the opposite effect of the foregoing, that of diminishing the formation of the bile, urea, and glycogen. Examples: Opium, quinine, arsenic, antimony, etc.

Ecbolics, or Oxytocics.—Agents which stimulate the pregnant uterus and produce contraction of that organ, either by direct irritation of the muscles of the womb, or indirectly by affecting the uterine center of the cord. Examples: Ergot, cotton-root bark, savin, cimicifuga, etc.

Emmenagogues.—Agents which stimulate the uterine muscular fibers and restore the normal menstrual function. Examples: Ergot, apiol, iron, etc.

Aphrodisiacs.—Agents used to excite the function of the genital organs when they are morbidly depressed. Examples: Phosphorus, zinc phosphide, salts of iron, gold, or arsenic, etc.

Anaphrodisiacs.—Agents which diminish the sexual desire. Examples: The bromides, camphor, etc.

Mydriatics.—Agents which cause dilatation of the pupil; used to temporarily destroy accommodation by causing paralysis of the ciliary muscle. Examples: Atropine and homatropine.

Myotics.—Agents acting in a manner contrary to that of the above, producing contraction of the pupil by stimulating the circular muscular fibers of the iris and at the same time contracting the ciliary muscle. Examples: Pilocarpine, eserine, etc.

Irritants.—Agents which are applied locally to the skin to produce certain effects, as rubefacients (simply reddening the skin); epispastics (blistering); pustulants (causing blebs in which is found pus); escharotics, or caustics (actually destroying the tissue). Examples: Mustard (rubefacient); cantharides (epispastic); croton oil (pustulant); caustic potassa, carbolic acid, and strong mineral acids (escharotics).

Local Sedatives.—Agents which diminish irritation in the part to which applied, relieving local inflammation. Examples: Acetate of lead, opium, belladonna, etc.

Demulcents.—Bland remedies used to allay and mechanically protect inflamed surfaces. They are used also internally for this purpose, as in acute inflammation of the alimentary canal. Examples: Mucilages of acacia, flaxseed, Iceland and Irish moss, elm, etc.

Emollients resemble the above; are used externally to soften and soothe the irritated and abraded skin. Examples: Lard, olive oil, cacao-butter, etc.

ANTISEPTICS.—Agents which arrest putrefaction, either by preventing the growth of micro-organisms causing putrefactive decomposition or by destroying these micro-organisms. Examples: Carbolic acid, corrosive sublimate, etc.

DISINFECTANTS.—Some authorities limit the use of this term to those agents which destroy the micro-organisms. The terms antiseptic and disinfectant are frequently used interchangeably. Examples: Corrosive sublimate, carbolic acid, iodoform, zinc chloride, eucalyptol, etc.

ANTIZYMOTICS.—A term applied to agents which arrest fermentation. Examples: See above.

ANTHELMINTICS.—Agents which destroy such parasitic worms as infest the alimentary canal. Tæniafuges destroy tape-worms; vermifuges expel these intestinal parasites. Examples: Santonin, spigelia, chenopodium, etc. Tæniafuges: Filix mas, pelletierin, cusso, etc.

ANTIPARASITICS.—Agents which destroy those parasites which infest the human body externally. Examples: Mercurial preparations, chrysarobin, carbolic acid, cocculus, etc.

ANTIPERIODICS.—See above.

Thus far we have only very briefly called attention to therapeutical and physiological action of drugs, giving but a few examples. We will temporarily leave the further consideration of this, and for the time refer to the therapeutical agents themselves.

TABLE OF THERAPEUTICAL AGENTS OF CHEMICAL NATURE (INORGANIC).

GROUP I.—THE ALKALINE METALS. POTASSIUM, SODIUM, AMMONIUM, AND LITHIUM.

The Official Potassium Salts.—Acetate, bicarbonate, bichromate, bitartrate, bromide, carbonate, chlorate, citrate, citrate effervescent, cyanide, ferrocyanide, hypophosphite, iodide, nitrate, permanganate, sulphate, hydroxide.

The Official Sodium Salts.—Acetate, arsenate, benzoate, bicarbonate, bisulphite, borate, bromide, carbonate, carbonate exsiccatus, chlorate, chloride, hypophosphite, hyposulphite, iodide, nitrate, nitrite, phosphate, phosphate effervescent, pyrophosphate, salicylate, sulphate, sulphite, phenolsulphonate.

The Official Ammonium Salts.—Benzoate, bromide, carbonate, chloride, iodide, valerianate, salicylate.

The Official Lithium Salts.—Benzoate, bromide, carbonate, citrate, citrate effervescent, salicylate.

GROUP II.—ALKALINE EARTHS AND ALLIES. CALCIUM, BARIUM, STRONTIUM, AND MAGNESIUM.

The Official Calcium Salts.—Bromide, precipitated carbonate, chloride, hypophosphite, precipitated phosphate, oxide.

The Official Barium Salt.—Dioxide (1890).

The Official Strontium Salts.—Bromide, iodide, salicylate.

The Official Magnesium Salts.—Carbonate, sulphate, sulphate effervescent, oxide.

GROUP III.—Cerium, Cadmium, Aluminum, Zinc.

The Official Cerium Salt.—Oxalate.

Cadmium Salts.—Sulphate, iodide (unofficial).

The Official Aluminum Salts.—Alum, alum dried, sulphate.

The Official Zinc Salts.—Acetate, bromide, Ppt. carbonate, chloride, iodide, oxide, phenolsulphonate, stearate, sulphate, valerate.

GROUP IV.—Lead, Silver, Copper, and Bismuth.

The Official Lead Salts.—Acetate, iodide, oxide, nitrate.

The Official Silver Salts.—Nitrate (crystallized, fused, diluted), oxide, cyanide.

The Official Copper Salt.—Sulphate.

The Official Bismuth Salts.—Bismuth and ammonium citrate, subsalicylate, subgallate, subcarbonate, subnitrate.

GROUP V.—Manganese, Iron.

The Official Manganese Salts.—Dioxide, sulphate, hypophosphite.

The Official Iron Salts.—Carbonate (saccharated), chloride (in sol. and tincture), citrate, hydrate, hypophosphite, iodide (syrup), reduced, phosphate (soluble), sulphate (granulated and exsiccated), iron and ammonium citrate, iron and ammonium tartrate, iron and potassium tartrate, iron and quinine citrate, iron and quinine citrate, soluble iron and strychnine citrate, oxide (hydrated), oxide with magnesia, pyrophosphate (soluble).

GROUP VI.—Gold and Mercury.

The Official Gold Salt.—Gold and sodium chloride.

The Official Mercury Salts.—Ammoniated, chloride (corrosive), chloride (mild), iodide (red and yellow), oxide (yellow, red), mercury with chalk.

GROUP VII.—Antimony and Arsenic.

The Official Antimony Salts.—Antimon. and potass. tartrate.

The Official Arsenic Salt.—Iodide, trioxide (also in 1 per cent. solution).

GROUP VIII.—INORGANIC ACIDS. Hydrochloric, Hydrobromic, Hydriodic, Nitric, Nitro-hydrochloric, Sulphuric, Sulphurous, Phosphoric, Hypophosphorous (Arsenous and Chromic).

GROUP IX.—THE HALOGENS. Chlorine, Bromine, and Iodine.

GROUP X.—Sulphur and Phosphorus.

GROUP XI.—Carbon, Boron, and Silicon.

CLASSIFICATION OF PHARMACEUTICAL CHEMICALS ACCORDING TO PROMINENT PHYSICAL CHARACTERS.

In the identification of chemicals there are two means by which they can be recognized. First, by physical, and second, by chemical properties. Sometimes it is impossible to distinguish different members of a class from each other by their physical properties; in that case chemical means must be resorted to.

The U. S. P., in describing chemicals, gives a physical description, a qualitative and quantitative test. For the ordinary identification of a

chemical or for a quick recognition, one is not obliged to remember even the tests for identity. But physical properties are so necessary that they should become so familiar to the student that he recalls them at once without effort. This comes to him by practice in handling the chemicals every day at the prescription or dispensing counter.

As an aid to this study a classification, based on purely physical characteristics, is desirable. An article having such a basis appeared in the Alumni Report of the Philadelphia College of Pharmacy, Nov., 1901, page 151. We have adopted in part the scheme there presented, as a suggestion for a systematic arrangement as above indicated. It is to be understood that the list may profitably be expanded.

CHEMICALS HAVING COLOR:

PALE VIOLET: Ferri et Ammonii Sulphas, acid styptic taste.
GREEN: Ferri Sulphas, nauseous metallic taste.
Ferri Sulphas Granulatus, saline, styptic taste.
Ferri Phosphas Solubilis, acidulous, slightly saline taste.
Ferri Pyrophosphas Solubilis, acidulous, slightly saline taste.
GREENISH-WHITE: Ferri Lactas, mild, sweetish ferruginous taste.
REDDISH-BROWN: Antimonium Sulphuratum, tasteless.
GREENISH-BROWN: Ferri Carbonatis Saccharatus, first sweetish, afterward slight ferruginous taste.
YELLOWISH-BROWN: Ferri et Quininæ Citras; bitter and mildly ferruginous taste. **(Scale salt.)**
PINK OR ROSE: Mangani Sulphas; slightly bitter and astringent taste.
YELLOW: Sulphur Sublimatum; slight odor of sulphuric acid, faintly acid taste.
Sulphur Lotum; odorless, tasteless.
Sulphur Præcipitum; odorless, tasteless.
Iodoform; odor characteristic.
Plumbi Iodidum; odorless, tasteless.
Plumbi Oxidum; odorless, tasteless.
Hydrargyri Iodidum Flavum; odorless, tasteless.
Potassii Ferrocyanidum; mild saline taste.
Hydrargyri Subsulphas Flavus; odorless, tasteless.
ORANGE YELLOW: Hydrargyri Oxidum Flavum; somewhat metallic taste.
Auri et Sodii Chloridum; saline, metallic taste.
Ferri Chloridum; deliquescent, styptic taste.
GREENISH-GOLDEN-YELLOW: Ferri et Quininæ Citras Solubilis; bitter, mildly ferruginous taste.
SAFFRON YELLOW: Bismuthi Subgallas; odorless and tasteless powder.
RED OR ORANGE RED: Arseni Iodidum; glossy masses, iodine-like odor.
Hydrargyri Oxidum Rubrum; somewhat metallic taste.
Potassi Bichromas, bitter metallic taste.
Potassii Ferricyanidum.
SCARLET: Hydrargyri Iodidum Rubrum, odorless, tasteless.
GARNET RED: Ferri Citras, very faint, ferruginous taste.
Ferri et Ammonii Citras; saline, mildly ferruginous taste.
Ferri et Strychninæ Citras; garnet-red to reddish-brown, sweetish and slightly ferruginous taste.
Ferri et Ammonii Tartras; garnet-red to reddish-brown, sweetish ferruginous taste.
Ferri et Potassii Tartras; garnet-red to reddish-brown, sweetish slightly ferruginous taste. **(All scale salts in this group.)**
DARK RED: Acidum Chromicum.
DARK PURPLE: Potassii Permanganas; sweet, afterwards disagreeable astringent taste.

BLUISH-BLACK: Iodum; sharp, acrid taste, irritant.
GRAYISH-BLACK: Sulphuris Iodidum; iodine odor, somewhat acrid taste.
Mangani Dioxidum; heavy, gritty, tasteless.
Ferrum Reductum; frequently of a lusterless black, gritty, tasteless.
DARK-GRAY: Zinci Phosphidum, odor and taste of phosphorus.
LIVER-BROWN: Potassii Sulphurata; bitter, alkaline taste (1890).
BROWNISH-BLACK: Argenti Oxidum; metallic taste.
DULL BLACK: Carbo Ligni; light powder, not gritty, odorless, tasteless.
Carbo Animalis; granular, fragments or powder, odorless, tasteless.
Carbo Animalis Purificatum; purified, fine, not gritty, odorless, tasteless.

COLORLESS, OR NEARLY SO:

PERMANENT IN AIR: Potassii Bitartras; odorless, pleasant, acidulous taste.
Potassii Nitras; odorless, cooling, saline and pungent taste.
Potassii Sulphas; odorless, somewhat bitter taste.
Alumen; odorless, sweetish, strongly astringent taste.
Potassii Bicarbonate; odorless, saline and slightly alkaline taste.
Acidum Tartaricum; purely acidulous taste.
EFFLORESCENT: Plumbi Acetas; faintly acetous odor, sweetish, astringent, afterwards metallic taste
Potassii et Sodii Tartras; odorless, cooling saline taste.
Sodii Acetas; odorless, cooling, saline taste.
Sodii Boras; odorless, sweetish alkaline taste.
Zinci Sulphas; odorless, astringent, metallic taste.
Acidum Citricum; purely acid taste, deliquescent in moist air.
Zinci Sulphocarbolas; odorless, slightly astringent, metallic taste.
Ammonii Carbonas; falls to a powder, but this is due to a slight decomposition, forming bicarbonate.
Sodii Carbonas; odorless, strongly alkaline taste.
Sodii Hyposulphis; odorless, bitter, then sweetish alkaline taste, deliquescent in moist air.
Sodii Sulphas; odorless, saline and somewhat bitter taste.
DELIQUESCENT SALTS: Ammonii Iodidum, Potassii Citras, Potassii Carbonas, Potassii Cyanidum, Potassii Acetas, Potassii Hypophosphas, Lithii Bromidi, Lithii Salicylas, Sodii Bromidum, Auri et Sodii Chloridum.
TABULAR CRYSTALS:
Argentii Nitras; odorless, bitter caustic, strongly metallic taste.
Potassii Chloras; lustrous, cooling, saline taste.
Ammonii Valerianas; odor of valerianic acid, sharp, sweetish taste.
CUBICAL:
Potassii Bromidum; odorless, pungent, saline taste.
Potassii Iodidum; peculiar, faint iodine-like odor, pungent, saline, afterwards bitter taste.
SWEET TASTE:
Alumen Exsiccatum; very slightly sweetish, strongly astringent taste.
Antimonii et Potassii Tartras; slightly sweet, afterwards disagreeable metallic taste.
Ammonii Salicylas; odorless, first slightly saline, bitter afterwards, sweet taste. (Plumbi acetas; sweetish, astringent, poison.)
Saccharum; hard monoclinic crystals
Saccharum Lactis; gritty on tongue.
Strontii Salicylas; odorless, slightly sweet, saline taste.
STRONGLY SALINE TASTE:
Ammonii Chloridum; cooling saline taste.
Potassii Hypophosphis; pungent, saline taste.
Sodii Iodidum.
Sodii Chloridum; pure saline taste.
Sodii Hypophosphis; bitter, slightly sweet saline taste.
Calcii Bromidum; sharp saline taste.
Potassii Acetas; warming saline taste.
Sodii Bromidum; odorless, saline, slightly bitter taste.
Ammonii Bromidum; pungent saline taste.

Zinci Bromidum; sharp, saline and metallic taste.
Zinci Iodidum; sharp, saline and metallic taste.
Strontii Bromidum; bitter saline taste.
Ammonii Iodidum; odorless, sharp, saline taste.

COOLING SALINE TASTE:

Potassii et Sodii Tartras.
Potassii Citras.
Sodii Sulphis (also sulphurous taste).
Sodii Chloras.
Sodii Nitras; slightly bitter.
Sodii Pyrophosphas; feebly alkaline.
Sodii Sulphocarbolas; somewhat bitter.

ALKALINE TASTE:

Sodii Arsenas; mild.
Potassii Carbonas, Sodii Carbonas; strongly alkaline
Sodii Bicarbonas; cooling.

MISCELLANEOUS:

Hydrargyri Chloridum Corrosivum; odorless, acrid, persistent, metallic taste.
Chloral; aromatic, penetrating and slightly acrid odor, bitterish caustic taste.
Plumbi Nitras; sweetish, afterwards astringent, metallic taste.
Menthol; strong and pure odor of peppermint, warm aromatic taste.
Thymol; aromatic, thyme-like odor, pungent aromatic taste.

MICACEOUS SCALES OR LAMINÆ; WHITE OR COLORLESS.

Bismuthi et Ammonii Citras; pearly, odorless, slightly acidulous, acidulous and metallic taste.
Calcii Hypophosphis; odorless, nauseous, bitter taste.
Ammonii Benzoas; slight odor of benzoic acid, saline, bitter, afterwards slightly acid taste.
Strontii Iodidum; odorless, bitterish, saline taste.
Zinci Valerianas; odor valerianic acid, sweet, afterward styptic and metallic taste.
Acidum Boricum; odorless, cooling, bitterish taste.
Acetanilidum; odorless, faintly burning taste.

SMALL PRISMATIC CRYSTALS OR NEEDLES.

LIGHT:

Benzoic Acid; odorless or characteristic odor of benzoin, warm, acid taste.
Acidum Gallicum; fawn colored, odorless, astringent or slight acid taste.
Acidum Salicylicum; odorless, sweetish, afterwards acrid taste.
Acidum Tannicum; odorless or faint characteristic odor, strongly astringent taste.

HEAVY:

Magnesii Sulphas; odorless, cooling, saline, bitter taste.

FINE POWDERS OR GRANULAR (OCCASIONALLY IN FUSED MASSES).

SWEET TASTE:

Sodii Benzoas; odorless or faint odor benzoin, sweetish, astringent taste.
Sodii Bisulphis; odor sulphur dioxide, disagreeable sulphurous taste.
Lithii Salicylas; odorless, sweetish taste.
Lithii Benzoas; odorless and faintly benzoic odor, cooling and sweetish taste.
Sodii Salicylas; odorless, sweetish saline taste.
Hydrargyrum cum Cretæ; odorless, slightly sweetish taste.

EARTHY TASTE:

Magnesia; odorless.
Magnesii Carbonas; odorless, slightly earthy taste.
Hydrargyrum Ammoniatum; odorless, earthy, afterwards styptic and metallic taste.

ALKALINE TASTE:
Lithii Carbonas; odorless.
Lithii Citras; odorless, cooling, faintly alkaline taste.
Calx Sulphurata; odor hydrogen sulfid, offensive alkaline taste.

ODORLESS AND TASTELESS:
Bismuthi Subnitras; almost tasteless.
Bismuthi Subcarbonas; white or pale yellowish white.
Argentii Cyanidum.
Cerii Oxalas.
Calcii Carbonas Præcipitatus.
Calcii Phosphas Præcipitatus.
Barii Dioxidum.
Zinci Carbonas Præcipitatus.
Bismuthi Salicylas.
Zinci Oxidum.
Ferri Hypophosphis, nearly tasteless.
Hydrargyrum Chloridum Mite.
Antimonii Oxidum.

MISCELLANEOUS:
Lithii Bromidum; odorless, sharp, somewhat bitter taste.
Calx Chlorata Hypochlorous; acid odor, disagreeable, saline taste.
Zinci Chloridum; odorless, very caustic, astringent, metallic taste.
Zinci Stearas; tasteless, very faint, fat-like odor.

AMORPHOUS MASSES:
Potassii Hydroxidum; odorless or faint odor of lye; very acrid and caustic taste.
Potassii Cyanidum; sometimes granular, very poisonous.
Sodii Hydroxidum; odorless, acrid, caustic taste.
Ammonii Carbonas; strong odor ammonia, free from empyreuma, sharp, saline taste.
Calx; odorless, sharp, caustic taste.
Calcii Chloridum; odorless, sharp saline taste.
Acidum Arsenosum (trioxide); odorless, tasteless
Amylum; irregular, friable, white.
Acidum Stearicum; hard, somewhat glossy white.
Camphor; colorless or white, odor characteristic, pungent, aromatic taste

MOBILE LIQUIDS.

ODOROUS, VERY VOLATILE, ODORS CHARACTERISTIC:
Chloroform; heavy.
Carbonii Disulphidum; heavy fetid odor, sharp aromatic taste.
Bromum; heavy, peculiar, suffocating odor.
Ether; light, burning, sweetish taste.
Benzine.
Alcohol.

SLOWLY VOLATILE:
Acidum Hydrocyanicum.
Acidum Hydrochloricum.
Acidum Nitricum.
Acidum Nitrohydrochloricum.
Aqua Chlori; greenish yellow, disagreeable odor and taste of chlorine
Aquæ Ammoniæ; pungent odor, acrid alkaline taste.
Acidum Aceticum; purely acid taste.

ODORLESS:
Aquæ Hydrogenii Dioxidum; makes soapy froth in mouth.
Dilute Acids and Water.

SYRUPY LIQUIDS.

Acidum Lacticum.
Acidum Phosphoricum.
Acidum Sulphuricum; oily, caustic taste.
Acidum Carbolicum. (Phenol Liquefactum.)
Glycerinum; oily, sweet, warm taste.
Acidum Oleicum; lard-like odor and taste.

ORGANIC CHEMICALS.

The medicinal organic compounds are very numerous, and the number is still increasing. They are the compounds of carbon and hydrogen and their derivatives, and may be classified under the following general heads:

CLASS I.—METHANE DERIVATIVES:

1 Hydrocarbons—
   - Saturated.
   - Unsaturated.
2. Halogen Substitution Products of the Hydrocarbons.
3. Alcohols—
   - Primary, Secondary, and Tertiary.
   - Monatomic, Diatomic, Polyatomic (or monacid, etc.).
4. Derivatives of Alcohols—
   - Esters.
   - Sulphur Derivatives of Alcohols and Ethers.
   - Inorganic Esters.
   - Nitriles.
   - Amines or Ammonium Bases, Hydroxylamines, and Hydrazines.
   - Metalloid Compounds, Phosphorus, Arsenic, etc.
   - Metallic Compounds.
5. Aldehydes and Ketones.
6. Acids (monobasic, dibasic, tribasic, etc.).
7. Derivatives of Acids—
   - Esters (ethereal salts).
   - Halogen Substitution Products and Haloids of the Acid Radicals.
   - Acid Anhydrides.
   - Thio-acids and Anhydrides.
   - Acid Amides and Amido Acids.
8. Cyanogen Compounds and their Derivatives.
9. Carbonic Acid Derivatives.
10. Carbohydrates.

Transition to the Aromatic Compounds.

1. Polymethylenes.
2. Furfurane, Thiophene, and Pyrrol.
3. Azoles, etc.

CLASS II.—BENZENE OR AROMATIC DERIVATIVES:

1. Hydrocarbons.
2. Halogen Derivatives.
3. Sulphur Derivatives.
4. Nitro Derivatives.
5. Amido Derivatives.
6. Other Nitrogen Derivatives.
   - Diazo Compounds.
   - Azo Compounds.
   - Hydrazines.
7. Phenols.
8. Alcohols, Aldehydes, and Ketones.
9. Acids.
10. Combinations of the above classes.

DOUBLE RING COMPOUNDS.

11. Indigo Group.
12. Diphenyl and its Derivatives.
13. Diphenyl-methane and similar compounds.
14. Triphenyl-methane and Derivatives, including certain dyes—
    1. Malachite Green Group.
    2. Rosaniline Group.
    3. Aurin Group.
    4. Eosin Group.

CONDENSED RING COMPOUNDS.

15. Naphthalene and its Derivatives.
16. Anthracene and its Derivatives.
17. Phenanthrene and its Derivatives.
18. Pyridine Group.
19. Chinoline Group.
20. Alkaloids of Complicated Composition.
21. Hydrated Benzenes (Terpenes and Camphors)
22. Tars and Glucosides.
23. Albumins and Albuminoids

The organic compounds of the various classes may be briefly defined as follows:

CLASS I.—METHANE OR FATTY ACID SERIES.

1. HYDROCARBONS of this series are the compounds of carbon and hydrogen, having the carbon atoms connected in a chain—thus, methane, CH_4; ethane, CH_3–CH_3; propane, CH_3–CH_3–CH_2.

    These compounds are the first of a series of compounds varying by the increment CH_2. They may be taken as illustrative of many such series of organic compounds, called homologous series.

    When there are four or more atoms of carbon in the molecule, the carbon atoms may form branching chains, as in isobutane.

    This compound has the same percentage composition, but has different properties from butane, CH_3–CH_2–CH_2–CH_3. This is called isomerism.

    Unsaturated hydrocarbons or derivatives have atoms of carbon united to one another by two or three bonds of affinity—thus, ethylene, $CH_2{=}CH_2$; acetylene, $CH{\equiv}CH$. These compounds will unite with halogens or halogen acids without an equivalent loss of hydrogen.

2. HALOGEN SUBSTITUTION PRODUCTS are hydrocarbons in which one or more atoms of hydrogen are replaced by a corresponding number of atoms of a halogen—thus, chloroform, $CHCl_3$; iodoform, CHI_3.

3. ALCOHOLS are formed by the replacement of one or more hydrogen atoms of a hydrocarbon by a corresponding number of hydroxyl (OH) groups. They are of neutral reaction, but analogous to metallic hydroxides. They combine with acids, losing water, forming compounds analogous to salts, termed esters. They may also be defined as hydroxyl combined with an alkyl radical*—thus, alcohol (ethyl hydroxide), C_2H_5OH.

Alcohols with one (OH) group are termed monatomic—thus, alcohol, ethyl alcohol, CH_3CH_2OH; with two (OH) groups are termed diatomic—thus, glycol, CH_2OH-CH_2OH; with three (OH) groups are termed triatomic—thus, glycerine, $CH_2OH-CHOH-CH_2OH$, etc. Those alcohols with two or more groups are called polyatomic. Alcohols are also divided into three classes. If the hydrogen substituted is in the methyl radical (CH_3), making the group CH_2OH, *primary* alcohols are formed; or, if the substitution is in the methylene radical (CH_2), making the group CHOH, *secondary* alcohols are formed; or, if the substitution is in the methine radical ($\equiv$CH), making the group $\equiv$COH, *tertiary* alcohols are formed.†

4. DERIVATIVES OF ALCOHOLS.—(*a*) Ethers are compounds of neutral reaction, derived from alcohols by the elimination of one molecule of water from two molecules of alcohol. They are analogous to the metallic oxides—thus, ether (or di-ethyl-oxide), $(C_2H_5)_2O$; ethyl-propyl-ether, $C_2H_5-O-C_3H_7$.

(*b*) Sulphur derivatives of alcohols and ethers are formed by

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* *Radicals.*—It is usual to designate as radicals those groups of atoms which are found repeating themselves in a comparatively large number of compounds derived from one another, and in which these combinations play the part of simple elements: *e. g.*, CH_3 is called the methyl radical, CH_3-Cl is methyl chloride, CH_3OH is methyl alcohol, etc. CH_3-CO- is termed the acetyl radical and C_2H_3O-Cl is acetyl chloride, etc.

† Groups of elements like the above are always found to have constant properties, and are said to be the *characteristic groups* in the classes in which they are found.

The principal groups of organic chemistry are the following:

Primary alcohols,	$-CH_2OH$.	Aldehydes,	$-COH$.
Secondary alcohols,	$=CHOH$.	Ketones,	$=CO$.
Tertiary alcohols,	$\equiv COH$.	Acids,	$-COOH$.
Ethers,	$\equiv C-O-C\equiv$	Sulphonic acids,	$-HSO_3$.
Nitriles,	$-C\equiv N$.	Nitro compounds,	$-NO_2$.
Amido compounds,	$-NH_2$.	Oximes,	$=NOH$.
Imido compounds,	$=NH$.		

replacing one or more atoms of oxygen by sulphur—thus, mercaptan, C_2H_5SH; ethyl-sulphid, $(C_2H_5)_2S$.

(*c*) Inorganic esters are compounds derived from the inorganic acids by the exchange of the replaceable hydrogen by an alcohol radical—thus, ethyl-nitrate, $C_2H_5-O-NO_2$. They are analogous to inorganic salts.

(*d*) Nitriles are compounds of hydrocyanic acid (HCN) in which the hydrogen is replaced by an alcohol radical—thus, aceto-nitrile or methyl-cyanide, CH_3CN. Iso-nitriles differ in properties from the nitriles by having the radical joined to the nitrogen—thus, CH_3NC.

(*e*) Nitrogen bases: Amines and ammonium bases are compounds formed by the introduction of one or more alcohol radicals in place of the hydrogen in ammonia or ammonium salts—thus, methylamine, CH_3NH_2; trimethylamine, $(CH_3)_3N$.

Amines are designated as primary, secondary (imines), tertiary (nitrile bases), or quarternary (ammonium bases), as one, two, or three atoms of hydrogen are replaced in ammonia, or as the four atoms of hydrogen are replaced in ammonium.

Hydroxylamines and hydrazines are compounds derived respectively from hydroxylamine and hydrazine as the amines are derived from ammonia—thus, methyl-hydroxylamine, NH_2OCH_3; methyl-hydrazine, CH_3-NHNH_2.

(*f*) Metalloid compounds: Phosphorus, arsenic, etc.

Phosphines are compounds derived from phosphine as the amines are derived from ammonia—thus, methyl phosphine, CH_3PH_2.

Arsines are compounds derived from arsine in the same manner, trimethyl arsine, $(CH_3)_3As$. Among the derivatives in this class are the cacodyles.

(*g*) Metallic compounds are combinations of the alcohol radicals with the metals—thus, zinc methyl, $Zn(CH_3)_2$; zinc ethyl, $Zn(C_2H_5)_2$.

5. ALDEHYDES AND KETONES are substances which result from the oxidation of primary and secondary alcohols respectively, with the separation of two atoms of hydrogen. Thus, aldehyde, (CH_3CHO), characterized by the group $-COH$; acetone dimethyl-ketone, $CH_3-CO-CH_3$, characterized by the group $=CO$.

Oximes are compounds derived from aldehydes and ketones by replacing the oxygen with the group $=NOH$. Thus, aldoxime, $CH_3-CH=NOH$; ketoxime, $(CH_3)C_2=NOH$.

6. ACIDS are oxidation products of the primary alcohols and the corre-

sponding aldehydes, and contain the characteristic group, $-COOH$, the hydrogen of which is replaceable by a metal to form a salt. Acids may be monobasic, dibasic, tribasic, etc., as they contain one or more of these groups—thus, acetic acid, CH_3-COOH; oxalic acid, $COOH-COOH$, etc.

7. Derivatives of Acids.—(*a*) Esters are compounds formed by replacing the typical hydrogen of an acid by an alcohol radical—thus, acetic ether (ethyl-acetic-ether, ethyl-acetate), $CH_3-COOC_2H_5$.

(*b*) Halogen Derivatives.—1. Substitution products in which the halogen replaces the hydrogen of the alcohol radical—thus, monochlor-acetic acid, $CH_2ClCOOH$.

2. Chlorides of the Acid Radicals.—The halogen replaces the hydroxyl (OH) of the acid group—thus, acetyl chloride, CH_3COCl.

(*c*) Acid Anhydrides.—Two molecules of an acid combined with the loss of water—thus, acetic acid anhydride, $(CH_3CO)_2O$.

(*d*) Thio-acids and Anhydrides.—Oxygen of the acids substituted by sulphur—thus, thiacetic acid, CH_3COSH.

(*e*) Amido Acids.—Compounds formed (1) by the replacement of the hydrogen of ammonia by acid radicals—thus, glycocoll (amido acetic acid), $CH_2(NH_2)COOH$.

(2) Acid Amides.—Compounds formed by replacing the OH of the acid by the amido group, NH_2—thus, acetamide, CH_3CONH_2.

8. Cyanogen Compounds and their Derivatives.—Those compounds derivable from cyanogen, C_2N_2; hydrocyanic or prussic acid, HCN; potassium ferrocyanide, $K_4Fe(CN)_6$; ethylthiocyanate, C_2H_5SCN.

9. Carbonic Acid Derivatives.—Compounds derivable by substitution from carbonic acid (H_2CO_3)—thus, ethyl carbonate, $CO(OC_2H_5)_2$; carbon oxychloride (phosgene gas), $COCl_2$; carbamide (urea), $CO(NH_2)_2$; guanidine, $CNH(NH_2)_2$; uric acid, xanthine, etc.

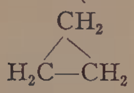
10. Carbohydrates.—Compounds of carbon, hydrogen, and oxygen containing two atoms less of hydrogen than the corresponding polyatomic alcohol. Chemically, they are aldehyde alcohols or ketone alcohols.

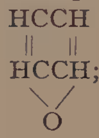
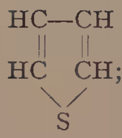
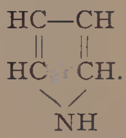
The principal groups are:

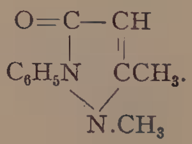
1. Grape sugar group, $C_6H_{12}O_6$.
2. Cane sugar group, $C_{12}H_{22}O_{11}$.
3. Cellulose group, $(C_6H_{10}O_5)_x$.

Transition to the Aromatic Compounds.

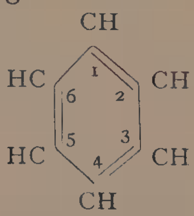
1. Polymethylenes are compounds containing three or more methylene (CH_2) groups joined in a ring—thus, tri-methylene,



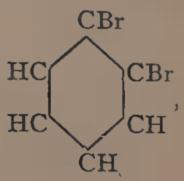
2. Furfurane, thiophene, and pyrrol are compounds in which four carbon atoms with one atom of either oxygen, sulphur, or nitrogen are joined in a ring—thus, furfurane,  thiophene,  pyrrol, 

3. Azoles contain two or more atoms other than carbon in a ring, and may be considered as derived from furfurane, thiophene, and pyrrol by replacing =CH– by =N–, —thus, pyrazole,  antipyrine (phenyldimethylpyrazolon), 

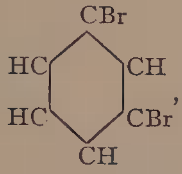
CLASS II.—BENZENE OR AROMATIC SERIES.

1. Hydrocarbons of this series are compounds containing carbon and hydrogen, having the carbon atoms connected in a ring—thus, benzene, C_6H_6, 

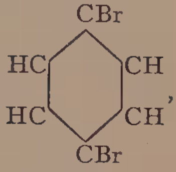
2. Halogen Substitution Products have an atom of hydrogen replaced by a halogen atom—thus, mono-chlor-benzene, C_6H_5Cl; dibrom-benzene, $C_6H_4Br_2$. C_6H_5 is called the phenyl radical; C_6H_4, the phenylene radical.

The di-substitution products may form three isomers according as the two are adjacent in the ring—thus, 

called ortho-di-brom-benzene; or as they have an atom of hydrogen between—thus,

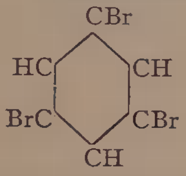


, called meta-di-brom-benzene; or as the atoms are opposite—thus,

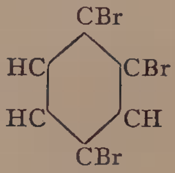


, called para-di-brom-benzene.

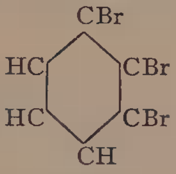
When three atoms are substituted, we have symmetrical



tri-brom-benzene; asymmetrical



tri-brom-benzene; and adjacent



tri-brom-benzene.

This method of nomenclature is used whenever any element or group takes the place of hydrogen.

3. Sulphur Derivatives of the aromatic series are analogous to those of the fatty acid series—thus, benzene sulphonic acid, $C_6H_5SO_3H$.

4. Nitro Derivatives are analogous to those of the methane series, but are more stable, and can be made by the direct treatment of the hydrocarbon with nitric acid—thus, nitro-benzene, C_6H_5-NO_2; tri-nitro-toluene, $C_6H_2CH_3(NO_2)_3$.

5. Amido Derivatives.—(1) Compounds formed by replacing one or more atoms of hydrogen in benzene or derivative hydrocarbons by one or more amido groups—thus, aniline (amido-benzene), $C_6H_5NH_2$; phenylene-diamine, $C_6H_4(NH_2)_2$.

(2) Compounds formed by replacing one or more atoms of hydrogen in ammonia by the aromatic hydrocarbon radicals—thus, diphenyl-amine, $(C_6H_5)_2NH$.

6. Other Nitrogen Derivatives.—Diazo, azo-compounds, and hydrazines: (*a*) Diazo-compounds are intermediate products in the conversion of amido compounds to alcohols by means of nitrous acid. They contain the characteristic group $-N=N-$ —thus, diazo-benzene-chloride, $C_6H_5-N=N-Cl$.

(*b*) Azo-compounds contain the same group as the diazo-compounds, but joined on each side to an alkyl radical—thus, azo-benzene (benzene-azo-benzene), $C_6H_5-N=N-C_6H_5$.

(*c*) Hydrazines are compounds derived by the replacement

of the hydrogen of hydrazine (N_2H_4) by one or more aromatic hydrocarbon radicals—thus, phenylhydrazine, $C_6H_5HN{-}NH_2$. They contain the characteristic group $=N{-}N=$.

7. PHENOLS are oxygenated derivatives of the benzenes. Chemically, they are midway between the alcohols and acids, and are formed by the replacement of H of the benzene nucleus by hydroxyl—thus, phenol (carbolic acid), C_6H_5OH; creosol, $C_6H_4(CH_3)OH$.

When two or more of the hydrogen atoms are replaced by the hydroxyl group, the polyacid phenols are obtained—thus, pyrocatechin (o-dioxy-benzene), $C_6H_4(OH)_2$; resorcin (m-dioxybenzene; and hydroquinone (p-dioxy-benzene). Tri-acid-phenols: $C_6H_3(OH)_3$, pyrogallic acid = o-trioxy-benzene; phloroglucin (s-trioxybenzene), oxyhydroquinone (a-trioxybenzene).

8. ALCOHOLS, ALDEHYDES, AND KETONES.—Analogous to the same compounds of the methane series, containing the same groups, replacing the hydrogen of the side-chains—thus, $C_6H_5CH_2OH$, benzyl alcohol; C_6H_5CHO, benzaldehyde; $C_6H_5C{=}OC_2H_5$, acetophenone.

9. ACIDS.—Compounds analogous to the acids of the methane series, capable of forming the same kinds of derivatives—thus, benzoic acid, C_6H_5COOH; toluic acid, $C_6H_4CH_3COOH$; phthalic acid, $C_6H_4(COOH)_2$.

10. COMBINATIONS OF THE ABOVE CLASSES.

DOUBLE RING COMPOUNDS.

11. INDIGO GROUP.—Compounds containing double rings similar to those of indigo—thus, indigo, $C_6H_4<{NH \atop CO}>C=C<{NH \atop CO}>C_6H_4$; isatin, $C_6H_4\left\langle {N \atop CO} \right\rangle C(OH)$; indol, $C_6H_4\left\langle {CH \atop NH} \right\rangle CH$.

12. DIPHENYL AND ITS DERIVATIVES.—Compounds containing two phenyl groups joined directly to each other—thus, diphenyl, $C_6H_5{-}C_6H_5$; benzidine (p-diamidodiphenyl), $C_6H_4NH_2{-}C_6H_4NH_2$.

13. DIPHENYL-METHANE AND SIMILAR COMPOUNDS.—Compounds in which two H atoms of methane are replaced by two phenyl groups, $(C_6H_5)_2$,—thus, diphenyl-methane, $CH_2(C_6H_5)_2$; benzophenone, $CO(C_6H_5)_2$.

14. TRIPHENYL-METHANE GROUP.—Compounds in which three H atoms of methane are replaced by the phenyl radical—thus, triphenyl-methane, $CH(C_6H_5)_3$; triphenyl-methane-carbinol, $C(OH)$-$(C_6H_5)_3$.

These compounds are of especial interest, including extensive series of dyes. The following groups of dyes are distinguished:

(1) Diamido-triphenyl-methane group (the bitter-almond-oil green group).

(2) Triamido-triphenyl-methane (the rosaniline group).

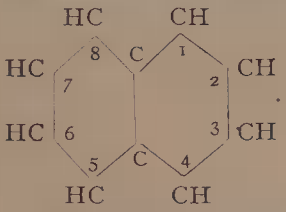
(3) Trioxy-triphenyl-methane (the aurin group).

(4) Triphenyl-methane-carboxylic acid (the eosin group).

For a more complete description of these dyes the student is referred to works on organic chemistry.

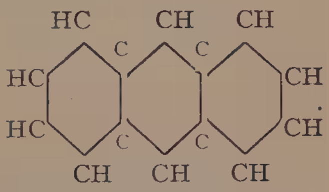
CONDENSED RING COMPOUNDS.

15. NAPHTHALENE AND ITS DERIVATIVES.—Naphthalene contains two condensed rings and has the composition $C_{10}H_8$; or, graphically,



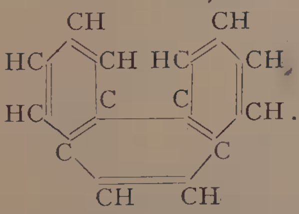
This is an increment of C_2H_4 over benzene. The hydrogen can be replaced as in benzene, forming derivatives—thus, $-C_{10}H_7OH$, naphthol; $C_{10}H_7NH_2$, naphthylamine, etc. When an atom of hydrogen connected to a carbon atom adjacent to either of the atoms of carbon common to both rings is replaced, alpha (α) derivatives of naphthalene are made. If those not adjacent are replaced, we have beta (β) derivatives.

16. ANTHRACENE AND ITS DERIVATIVES.—Anthracene contains three condensed rings, $C_{14}H_{10}$, or, graphically,



This is an increment of C_4H_2 over naphthalene. The hydrogen can be replaced as in benzene, forming derivatives—thus, $C_{14}H_8O_2$, anthraquinone; $C_{14}H_8O_4$, alizarine.

17. PHENANTHRENE AND ITS DERIVATIVES.—Phenanthrene is an isomer of anthracene, containing three condensed rings—thus,



It can form derivatives in the same way.

Pyridine derivatives, alkaloids, and compounds related to

them. These are compounds that may be considered as derived from benzene, naphthalene, anthracene, by the exchange of $-N=$ for $-CH=$ in the rings. All may be considered as derived from benzene on the one hand and from pyridine on the other.

18. PYRIDINE GROUP.—Pyridine may be considered as benzene in which $=CH-$ is exchanged for $=N-$. The hydrogen of pyridine is replaceable, forming derivatives such as picoline (methyl-pyridine), $C_5H_4NCH_3$.

Hydrated pyridine or piperidine, $C_5H_{11}N$; conine, α-normal-propyl-piperidine, $C_5H_{10}N(C_3H_7)$.

19. QUINOLINE AND ACRIDINE GROUPS bear the same relation to pyridine that naphthalene and anthracene bear to benzene.

20. ALKALOIDS OF COMPLEX OR UNKNOWN COMPOSITION.—Included in this class are the tropine, opium, narcotine, cinchona, strychnine, and solanine bases.

21. HYDRATED DERIVATIVES OF BENZENE.—Terpenes are hydrocarbons of the general formula $(C_5H_8)_x$, or, most commonly, $C_{10}H_{16}$. Camphors are oxygen derivatives of the terpenes: $C_{10}H_{16}O$, camphor.

22. GLUCOSIDES are vegetable substances that, when treated with alkalies, acids, or enzymes, are so broken up that one of the products of the decomposition is a glucose. They are ethereal derivatives of these sugars (?).

23. RESINS.—The resins are closely related to the terpenes and are formed from them. Their composition is as yet unknown.

24. ALBUMIN AND ALBUMINOIDS make up the greater part of the animal organism, and are also found in plants, especially in the seeds. The composition is as yet in doubt.

As before stated, many of these organic compounds are mere mixtures of synthetical chemicals. They have the alluring titles of "New Remedies," for which special merit is claimed. Many of them have certain euphonic titles, which give no information as regards their constituents; others have proper scientific names, which tell at once their composition. Virgil Coblentz, referring to their nomenclature, divides them into two classes, as follows:

CLASS I.—TITLES OF ORGANIC CHEMICALS.

(*a*) Titles of this class express concisely the composition (chemical) of the compound—as, for example, acet-anilid, benz-anilid, ethylene-diamine, ethoxyl-caffein, acety-ethyl-phenyl-hydrazine.

(*b*) Such titles as embrace euphonic combinations of different sylla-

bles of names of the bodies entering into the composition of the remedy—for example, tann-albin (compound of tannin and albumin); amyl-form (a combination of starch and formaldehyde); sali-pyrine (a compound of salicylic acid and antipyrine); lacto-phenin (lactic acid derivative of phenetidin); gall-al (aluminum gallate); gall-anol (gallic acid and anilid), etc.

CLASS II.—DESCRIPTIVE TITLES.

These are especially coined euphonic titles, which are generally of Greek and Latin origin, and partake of a descriptive character. These describe, in a way, either the uses, properties, or physical characters of the compound—as, for example, pyoktanin is made up of the Greek words πύον, meaning pus, and κτείνο, to kill; thalline, from the Greek, θαλλός, meaning a green twig, referring to the bright green color produced by the action of the oxidizing agents.

Other titles are of arbitrary character, such as loretin, an adaptation from *laura*, or *lorenit*, in which the last three letters of loretin have been reversed.

Owing to the entire absence of any data upon the nomenclature of these remedies, the derivation of many of these titles is entirely a matter of conjecture.

TITLES OF NEW REMEDIES.

The following synopsis of new remedies aims to include such agents as have some promise of becoming permanent additions to the Materia Medica, giving merely the name, chemical formula, brief statement as to physical properties, use and dose; the idea being to give simply a general survey of the newer remedies admitted, or seeking admission, into the list of recognized therapeutical agents. Some are recognized as modern synthetic medicinal products. Dr. Virgil Coblentz gives a most interesting résumé of these in the "Journal of the Society of Chemical Industry," February, 1904, No. 3, vol. xxiii, special reprints of which have been issued. The selection below has been made from prescription files.

ACETANILID (**Acetanalidum** U. S.).—$C_6H_5NH.COCH_3$. Analgesic, nerve sedative, and germicide. Dose, 0.2 to 0.5 Gm. (3 to 8 gr.).

ACETONE (**Acetonum** U. S.).—$CH_3.CO.CH_3$. Nervine. Dose, 5 to 15♏︎ (0.3 to 1 Gm.).

ACETOPYRIN.—Compound of antipyrin and acetyl salicylic acid, sparingly soluble in alcohol. Antiseptic. Prompt and energetic in migraine, acute articular rheumatism, etc., in doses of 0.5 to 1 Gm. (7½ to 15 gr.) in cachets.

ACETOZONE.—(Benzoyl-acetyl-peroxide.) $CH_3COOOCOC_6H_5$. An exceedingly hygroscopic powder, therefore diluted with 50 per cent. inert substance. Decomposed by water contact into its respective hydrogen peroxides, a most powerful germicide, without toxicity. Intestinal antiseptic, especially valuable in typhoid fever. One Gm. (15 gr.) in one liter (1 qt.) water; 100 cubic centimeters (4 fluid oz.) to be taken every four hours.

Acid Camphoric (U. S.).—$C_8H_{14}(COOH)_2$. Anhidrotic. Dose, 15 gr. (1 Gm.).

ACTOL.—(Silver Lactate.) $AgC_3H_5O_3 + H_2O$. Grayish white powder, soluble in 15 parts water. Without caustic action on wounds. Solutions must be protected from light.

ADRENALIN.—Solution of adrenalin chloride. Active principle of the adrenal gland. The most powerful astringent and hemostatic known; one drop of the solution 1 in 10,000 will blanch the mucous membrane of the eyelid in one minute. Valuable in coryza, hay-fever, hemorrhage, iritis, laryngitis, surgical operations, etc.

ALUMNOL.—$[C_{10}H_5OH(SO_3)_2]_3Al_2$. (Aluminum b-naphthol-di-sulfonate.) Antiseptic astringent. In 1 to 2 per cent. solutions, principally in gonorrhea, also as a gargle.

ANTIPYRINE.—$C_3N_2HO(CH_3)_2C_6H_5$. Antipyretic, antirheumatic, and antineuralgic. Dose, 15 to 30 gr. (1 to 2 Gm.).

ARGONIN.—(Argentum-caseinicum.) Compound of silver with casein, representing about 7 per cent. of its weight of silver nitrate. Soluble in water, non-irritant, and non-precipitated by soluble chlorides. Antiseptic, chiefly in gonorrhea, as a 2 per cent. solution.

ARGYROL.—(Silver Vitellin.) Compound of nuclein and silver, 30 per cent. Closely allied to argonin. Therapeutically, used locally.

ARISTOL.—$[C_6H_2(CH_3)(C_3H_7)OI]_2$. (**Thymolis Iodidum** U. S.) A red-brown sticky powder, soluble in absolute alcohol, ether, chloroform, fixed oils, and camphor carbolate, insoluble in water and glycerin. Employed in most skin affections, etc. Dose, 0.125 Gm. (2 gr.).

ASPIRIN.—(Acetyl-salicylic-acid.) White powder, sparingly soluble in water, freely in alcohol. Antirheumatic in doses 0.1 to 0.3 Gm. in capsule; 0.5 to 1 Gm. per diem.

Benzaldehyde (U. S.).—$C_6H_5.COH$. Contained in bitter almond oil.

BENZOSAL.—(Guaiacol-Benzoate.) $C_{14}H_{12}O_3$. Colorless, crystalline powder, nearly tasteless and odorless. Intestinal antiseptic. Dose, 0.2 to 0.6 Gm. (1 to 3 gr.) per day.

BROMOFORM.—$CHBr_3$. Anæsthetic, a remedy in whooping-cough. Dose, 2 to 5 drops (0.1 to 0.3 Gm.).

CHINOSOL.—(Potassium oxyquinolin-sulphate.) Bright yellow crystalline powder. Powerful antiseptic in the treatment of catarrh, ulcers, etc.; of great value in dentistry as an antiseptic mouth-wash (1 : 1,000), not affecting injuriously the gums or teeth.

CHLORAL HYDRATE (**Chloralum Hydratum** U. S.).—$C_2HCl_3O + H_2O$. Hypnotic. Dose, 10 to 20 ♏ (0.6 to 1.25 Gm.).

CHLORALAMIDE.—(**Chloralformamide** U. S.). $CCl_3CH.OH.CONH_2$. Soluble in nine parts of water. Hypnotic. Dose, 10 to 30 gr. (0.65 to 2.0 Gm.).

CHLORETONE.—(Chloroform Acetone.) $HO.C(CH_3)_2CCl_2$. White crystals. The saturated solution is used as a local anæsthetic. Internally hypnotic. Dose, 1 to 4 Gm. (15 to 60 gr.).

Cinnaldehyde (U. S.)—$C_6H_5.CH = CH.COH$. In cinnamon oil (or synthetic oil).

CREASOTAL.—(Beechwood Creasote 90 per cent. and carbolic acid.) A viscid, amber-colored, nearly odorless and tasteless liquid, insoluble in water and glycerin. Preferred to creasote in the treatment of tuberculosis, also in typhoid fever. In capsules, in oil, or in emulsion. Dose, 1 to 16 Gm.

Cresol (U. S.).—$C_6H_4(CH_3)OH$. Antiseptic. Dose, 1 ♏ (0.05 Cc.).

CROTON CHLORAL.—(Butyl Chloral Hydrate.) $C_4H_5Cl_3O + H_2O$. Action and dose same as chloral hydrate.

DERMATOL or **Bismuth Subgallate** (U. S.).—A fine saffron yellow powder. A substitute for iodoform in the treatment of wounds, ulcers, etc.

DIABETIN.—$C_6H_{12}O_6$. A variety of levulose used as a substitute for cane sugar in the regimen of diabetic patients. Only an inconsiderable portion of it is excreted with the urine.

Di-iodoform.—$C_2H_2I_4$. Used as a substitute for iodoform.

Dionin.—(Ethyl-morphine-hydrochlorate.) $C_2H_5O(OH)C_{17}H_{17}NO.HCl + H_2O$. Local anæsthetic, sedative, analgesic, chiefly used in ophthalmic practice. Dose, $\frac{1}{64}$ to $\frac{1}{16}$ gr.

Diuretin.—(Theobromine Sodium Salicylate.) $C_7H_7N_4O_2Na + C_6H_4(OH)$-$COONa$. White amorphous powder. Diuretic. Acts directly upon the kidneys without producing insomnia and depression. Dose, 15 gr. (1 Gm.).

Ethyl Bromide.—C_2H_5Br. Colorless, very volatile, non-inflammable liquid of a chloroformic taste and odor. Employed in minor surgery for general anæsthesia.

Ethyl Chloride (**Æthylis Chloridum** U. S.).—C_2H_5Cl. Local anæsthetic, producing no shock, vomiting, or nausea.

Eucaine Hydrochlorate B.—(Benzoyl-vinyl-diaceton-alkamine.) $C_{15}H_{21}NO_2$-HCl. A white crystalline powder. Less toxic than cocaine, does not produce mydriasis or corneal disturbances. In ophthalmic practice used in 2 per cent., in genito-urinary diseases, 0.5 to 2 per cent., for infiltration anæsthetic 0.1 to 1 per cent., solutions.

Eucalyptol (U. S.).—(Cineol). $C_{10}H_{18}O$. In eucalyptus oil. Dose, 5 ♏ (0.3 Cc.).

Eugenol (U. S.).—$C_6H_3(OH)(OCH_3).C_3H_5$. Synthetic clove oil.

Euphorin.—Phenyl-urethane. $C_6H_5NH—CO—OC_2H_5$. Colorless crystalline powder. Antipyretic, analgesic, etc. Dose, 0.13 to 0.5 Gm. (2 to 8 gr.).

Euquinine, Euchinin.—$C_2H_5O.CO.OC_{20}H_{23}N_2O$. Carbonic acid ester derivative of quinine. White crystals, devoid of bitterness, tasteless quinine compound. Given to children in mucilaginous vehicle.

Europhen.—$C_4H_9(OCH_3)C_6H_3.C_6H_2.C_4H_9(CH_3)OI$. A cresol derivative containing 22 per cent. of iodine. A yellow powder insoluble in water. Antiseptic as a 3 per cent. ointment for burns, scalds, and ulcers; as antisyphilitic, in solution in a fixed oil hypodermically. Dose, $\frac{1}{4}$ to 1 gr. ($\frac{1}{60}$ to $\frac{1}{15}$ Gm.). Must not be confounded with euphorin.

Exalgin.—$C_6H_5N(CH_3)(CH_3CO)$. Analgesic, dose, 3 to 6 gr. (0.2 to 0.4 Gm.); antipyretic, $7\frac{1}{2}$ gr. (0.5 Gm.).

Exodin.—(Diacetyl-rufigallic-acid-tetramethyl-ether.) Purgative. Dose, $7\frac{1}{2}$ to 12 gr. (0.5 to 0.8 Gm.).

Formaldehyde.—$HCOH$. A 37 per cent. solution (U. S. P.) of formic aldehyde ($HCOH$). Antiseptic and disinfectant. A powerful bactericide even when largely diluted. A spray of 2 per cent. solution completely disinfects fabrics; 0.5 to 1 per cent. solution to disinfect rooms, walls, furniture, etc.

Guaiacol (U. S.).—$C_6H_4—OHOCH_3$. The chief constituent of creasote, which contains it in varying proportions of 60 to 90 per cent. A colorless liquid of a strong aromatic odor. Dose, 1 to 2 drops for children, 3 to 5 drops for adults, dissolved in water with cognac and wine. Must be administered continuously for months.

Guaiacol Carbonate (U. S.).—$CO_3(C_6H_4OCH_3)_2$. An odorless, tasteless, crystalline powder, insoluble in water. Dose, 0.2 to 0.5 Gm., increased to 6 Gm. per day. More readily borne by the stomach than guaiacol itself. (*Synonym*, Duotal.)

Heroin.—(Morphine di-acetic-ester.) $C_{17}H_{17}NO_3\begin{matrix}CH_3CO\\CH_3CO\end{matrix}$. White crystals. The hydrochlorate in small doses, from 0.005 to 0.03 Mgm. ($\frac{1}{12}$ to $\frac{1}{2}$ gr.), in laryngeal cough, bronchitis, pulmonary tuberculosis; usually associated with other agents—terpin hydrate, etc

Holocain.—$CH_3C\begin{matrix}N—C_6H_4OC_2H_5\\N—C_6H_4OC_2H_5\end{matrix}$. Muscular anæsthetic, germicidal (poison).

Hypnone.—$C_6H_5COCH_3$. Soporific, hypnotic. Dose, 1 to 3 ♏.

Ichthyol.—$C_{28}H_{36}S_3O_6(NH_4)_2$. Ammonium sulphichthyolate and sodium sulphichthyolate are both employed under the name ichthyol. The latter, owing to its density, being dispensed when pills are prescribed, the former in ointments. Dark-brown semi-liquids of a fetid odor. Employed in a host of maladies, including eczema, bruises, burns, rheumatism, migraine, chilblains, etc.; also used in form of impregnated cotton, gauze, or soap.

Iodol (**Iodolum** U. S.).—C_4I_4NH. Antiseptic and alterative. Dose, 5 to 10 gr.

LACTOPHENIN.—$C_6H_4\begin{matrix}OC_2H_5\\ NH.CO.CH(OH)CH_3\end{matrix}$. Chemically resembling phenacetine Antipyretic and antirheumatic. Soluble in 40 parts of water. The daily dose is 10 to 40 gr. in divided quantities.

LYSIDIN.—(Ethylene-ethenyl-diamine.) $(CH_2N)(CH_2NH)CCH_3$. (Methyl-glyoxalidin.) A very hygroscopic, pinkish-white, alkaline mass. Comes in the form of 50 per cent. aqueous solution only. Said to possess five times the uric-acid solvent power of piperazine. Thirty to 150 minims in one pint or more of aerated water.

MERCUROL.—(Mercurous Nuclein.) Brownish-white powder; contains 10 per cent. of mercury. It does not precipitate albumen and is employed dissolved in physiologic salt solution.

Methylene Blue.—(**Methylthioninæ Hydrochloridum** U. S.). $C_{16}H_{18}N_3SCl$. A blue aniline similar to the agent following. Anodyne, antiperiodic, analgesic, bactericide. Employed especially in carcinomatous growths. Dose, 0.1 to 0.5 Gm. (hypodermically). The crystalline powder has a dark-green color.

METHYLENE VIOLET.—(Pyoktanin Cœruleum.) Also called methyl-blue. Violet crystalline powder. Excellent bactericide and deodorant. Deeply penetrates the tissues and colors the urine. Applied to purulent wounds, malignant tumors, chancroids, etc.

MIGRANIN.—A combination of 89.4 per cent. of antipyrin, 8.2 per cent. of caffein, 0.56 per cent. of citric acid. For migraine and as a general analgesic.

Naphthalenum.—$C_{10}H_8$. Antiseptic.

NAPHTOL (**Betanaphthol** U. S.).—$C_{10}H_7OH$. Antiseptic. Dose, 0 25 Gm. (4 gr.).

NARGOL.—(Silver Nuclein.) Contains 10 per cent. of silver. (Allied to Argyrol.)

NOSOPHEN.—(Tetra-iodo-phenolphthalein.) $(C_6H_2I_2OH)_2C\begin{matrix}\diagup C_6H_4CO\\ \diagdown O \diagup\end{matrix}$. Also known as iodophen; containing 60 per cent. of iodine. Pale yellow, odorless, and tasteless powder. Its sodium salt is known as antinosin, the bismuth salt as eudoxin. A harmless yet efficient substitute for iodoform.

OREXIN.—(Phenyl-dihydro-chinazoline.) $C_6H_4CH_2NC_6H_5NCH$. Colorless, lustrous, odorless crystals of bitter, pungent taste. Dose, 0.13 to 0.4 Gm. (2 to 6 gr.).

PARAFORM.—$(H.COH)_3$. Intestinal antiseptic. Dose, 7½ to 15 gr. (0.5 to 1 Gm.).

Paraldehyde (U S.).—$C_6H_{12}O_3$. Hypnotic. Dose, ♏ xv to ʒj (1 to 4 Cc.).

PERONIN.—$C_6H_5CH_2O(OH)C_{17}H_{17}NO.HCl$. Feeble narcotic. Dose, ⅓ to 1 gr. ($\frac{1}{45}$ to $\frac{1}{15}$ Gm.).

PHENACETIN.—$C_6H_4\begin{matrix}\diagup NH—CH_3CO.\\ \diagdown OC_2H_5\end{matrix}$ (**Acetphenetidinum** U. S.)—Antipyretic and analgesic. Dose, 7.5 gr. (0.5 Gm.)

PHENOCOLL HYDROCHLORIDE.—(Amido-acetparaphenetidin Chloride.) $C_6H_4(OC_2H_5)NHCOCH_2NH_2HCl$. A white powder of a slightly saline taste. Antipyretic, in typhoid fever and pneumonia and in various forms of rheumatism and neuralgia. Dose, 8 to 15 gr. (0.5 to 1.0 Gm.).

PIPERAZINE.—(Piperazidine, Diethylen-diamine, Dispermine.) $NH(CH_2)_4NH$. A colorless crystalline body of alkaline reaction, hygroscopic, taste not unpleasant. A powerful solvent of uric acid; recommended for gravel, renal and vesical calculi, for gout and diabetes. Dose, 1 Gm. (15 gr.).

PROTARGOL.—Protein combination with silver, 8.3 per cent. Yellowish hygroscopic powder. Used in ophthalmic practice, etc.; also in suppositories and as dusting powder on chancre. (See also *Nargol.*)

RESORCIN (**Resorcinol** U. S.).—(Meta-dioxy-benzol.) $C_6H_4(OH)_2$. Antiseptic.

SAFROL.—$C_6H_3(C_3H_5)\begin{matrix}O\diagdown\\ O\diagup\end{matrix}CH_2$. (**Safrolum** U. S.) In sassafras oil.

SALIPYRIN.—$C_{11}H_{12}N_2OC_7H_6O_3$. Compound of antipyrine and salicylic acid. Dose, 0.1 to 0.5 Gm.

SALOL.—(**Phenyl Salicylas** U. S.). $C_6H_4\begin{matrix}\diagup OH\\ \diagdown COOC_6H_5\end{matrix}$. Antipyretic. Dose, 0.3 to 0.6 Gm. (5 to 10 gr.).

SALOPHEN.—$C_6H_4\begin{cases} OH \\ CO_2C_6H_4NHCOCH_3 \end{cases}$ Derivative of phenol and salicylic acid, resembling salol. White leaflets, odorless and tasteless. Antirheumatic, in doses of 0.2 to 0.4 Gm.

Serum Antitoxins.—The blood-serums of immunized animals. A class of preparations employed hypodermically for the treatment of diseases of germ origin, such as diphtheria, etc. They have the power of neutralizing the toxin produced by the microorganism or germs. **Serum Antidiphthericum** U. S.

SODIUM CACODYLATE.—$O = As\begin{cases} CH_3 \\ CH_3 \\ ONa \end{cases}$. Dose, 0.25 Gm. (4 gr.) per os.

SODIUM ETHYLATE.—CH_3CH_2ONa. Whitish powder, decomposed in the presence of water into alcohol and caustic soda. Depilatory.

SOZOIODOL.—$C_6H_2I_2(OH)SO_3H + 3H_2O$. Usually supplied similar to potassium sozoiodal (which see), but more soluble.

SULPHONAL (**Sulphonmethanum** U. S.).—(Diethyl-sulphon-dimethyl-methane.) A whitish crystalline substance, devoid of odor or taste. Dose, 1 Gm. (15 gr.).

TANNALBIN.—Compound of tannin and albumen, tasteless powder, containing 50 per cent. of tannin. Astringent. Dose, 1 to 2 Gm. (8 to 15 gr.).

TANNIGEN.—(Diacetyl Tannin.) $C_{14}H_8(COCH_3)_2O_9$. Derivative of tannin, grayish-yellow, odorless, tasteless powder. An intestinal antiseptic, capable of passing the stomach unaltered. Dose, 1 Gm.

TANNOPIN.—(Tannon.) $2(CH_2)_6N_4(C_{14}H_{10}O_9)_3$. Compound of urotropin and tannin. Brown, odorless, tasteless powder. Dose, 0.5 to 1.0 Gm.

TETRONAL.—$(C_2H_5)_2C(SO_2C_2H_5)_2$.

THIOCOL.—$CH_3\begin{cases} OH \\ OCH \\ SO_3K \end{cases}$. (Potassium Guaiacol Sulphonic Acid.) Combines the full power of creasote and guaiacol.

TRICHLORACETIC ACID.—CCl_3COOH. Used as a caustic.

TRICRESOL.—(Ortho, meta and para cresol.) Disinfectant and germicide.

TRIONAL (**Sulphonethylmethanum** U. S.).—$C_2H_5CH_3C(SO_2C_2H_5)_2$. Derivative of sulphonal. Lustrous scales. Nerve sedative and hypnotic. Dose, 0.2 to 0.3 Gm

URETHANE.—$CO\begin{cases} NH_2 \\ OC_2H_5 \end{cases}$. (**Æthylis Carbamas** U. S.) Hypnotic. Dose, 1 to 2 Gm. (15 to 30 gr.).

URICEDIN.—Produced by action of sulphuric and hydrochloric acids on lemon juice and neutralizing the product with sodium bicarbonate. Slightly yellow granular substance. In the treatment of the uric acid diathesis. Dose, ½ to 1 teaspoonful in hot water, two or three times a day, up to 300 gr. per day.

UROTROPIN.—(**Hexamethylenamina** U. S.) $(CH_2)_6N_4$. Formed by the union of formaldehyde and ammonia. Diuretic and uric acid solvent. For uric acid calculi, cystitis. Dose, 0.25 to 1 Gm. (4 to 15 gr.).

VANILLIN.—$C_6H_3(OH)(OCH_3)COH$. From vanilla bean.

XEROFORM.—$(C_6H_2Br_3O)_2BiOH—Bi_2O_3$. Deodorant and astringent and antiseptic.

For more complete lists and fuller descriptions refer to such books as "The Newer Remedies," by Virgil Coblentz; "A Syllabus of New Remedies," by J. W. Wainwright, M.D., etc.

SYNONYMS.

There are perhaps few who know that many of the new remedies sold under fanciful trade names are identical with remedies having dissimilar names, or are old preparations which have been given fancy names in order to create a market for them.

The "California State Journal of Medicine" has published a long list of these synonyms, and states that there is no question of substitution involved when the pharmacist supplies a given name article under any one of its synonomous names.

This list of synonyms mentioned includes the following:

Adeps lanæ hydrosus; *syn.*,	Anasalpin, Lanolin, Lanum.
Argentum Colloidale; *syn.*,	Argentum Crede, Collargol, Colloidal silver
Beta-naphthol Benzoate; *syn.*,	Benzo-naphthol, Benzoyl-beta-naphthol.
Beta-naphthol Salicylate; *syn.*,	Betol, Naphtalol, Naphthosalol, Salinapthol.
Bromacetanilid; *syn.*,	Antisepsin, Asepsin.
Bismuth-iodo-subgallate; *syn.*,	Airol, Airogen, Airoform.
Calcium Beta-naphthol Sulphonate; *syn.*,	Abrastol, Asaprol.
Creasote Tannate; *syn.*,	Creosal, Tannosal.
Dimethyl-ethyl-carbinol Chloral; *syn.*,	Dormiol, Amylene-chloral.
Dithymol Diiodid; *syn.*,	Aristol, Annidalin, Di Thymol Iodid, Di Iodo Dithymol, (And several other similar names).
Epinephrin; *syn.*,	Adnephrin, Adrenalin, Adrenamine, Adrenol, Adrin, Caprenalin, Hemisine, Hemostatin, Suprarenalin.
Ethyl Chlorid; *syn.*,	Antidolorin, Ethylol, Kelene, Mono-chlor-ethane.
Hexamethylene-tetramine; *syn.*,	Aminoform, Ammonio-formaldehyde, Cystamine, Cystogen, Formin, Saliformin, Urotropin.
Hexamethylene Anhydromethylen Citrate; *syn.*,	Helmitol.

Levulose; *syn.*,	Diabetin, Fructose, Fruit sugar.
Ortho-ethoxy-ana-mono-benzoyl-amido-chin-olin; *syn.*,	Benzanalgene, Analgen, Quinalgen.
Paraphenetin Carbamid; *syn.*,	Dulcin, Sucrol.
Phenyl-dimethyl-parazolon; *syn.*, (Pharm. Germ.)	Analgesin, Anodynin, Antipyrin, Dimethyloxy-quinizin, Methozan, Phenazon (Br. Ph.), Phenylon, Pyrazin, Pyrazolin, Parodyn, Salozolon, Sedatin.
Phenylacetamide; *syn.*,	Acetanilid, Antifebrin, (And several hundreds of trade names for headache powders, etc.).
Phenylmethyl-ketone; *syn.*,	Acetophenone, Hypnone.
Plant Pepsin; *syn.*,	Papain, Papoid, Papayotin, Caroid.
Salicylic Acid Ester of Quinine; *syn.*,	Salochinin, Saloquinin.
Salicylate of Salochinin; *syn.*,	Rheumatin.
Sodium Sulpho-caffeate; *syn.*,	Nasrol, Symphoral.
Thyroid Gland, dried lactose trituration; *syn.*,	Iodothyrine, Thyroidin.
Trioxymethylen; *syn.*,	Paraformaldehyde, Paraform, Triformol.
Abrin; *syn.*,	Jequiritin.
Acetyl-salicylic Acid; *syn.*,	Aspirin.
Aluminum Aceto-tartrate; *syn.*,	Alsol.
Australian Oil Eucalyptus; *syn.*,	Flucol.
Bismuth Chryssophanate; *syn.*,	Dermol.
Bismuth Phosphate (soluble); *syn.*,	Bisol.
Bismuth Pyrogallate: *syn.*,	Helcosol
Bismuth Subgallate; *syn.*,	Dermatol.
Bismuth Beta-naphtholate; *syn.*,	Orphol.
Calcium Permanganate; *syn.*,	Acerdol.
Calcium Salicylate; *syn.*,	Colchicin.
Catarin Hydrochlorid; *syn.*,	Stypticin.
Chloretone (1 per cent. solution); *syn.*,	Aneson.
Creosote Carbonate; *syn.*,	Creosotal.
Diethylen-diamin; *syn.*,	Piperazin.
Dimethyl-xanthine; *syn.*,	Theobromine.
Guaiacol Carbonate; *syn.*,	Duotal.
Laricinic Acid; *syn.*,	Agaricin.
Magnesium Dioxid; *syn.*,	Biogen.

Oxyquinaseptol; *syn.*, ...Diaphtherin.
Phenyl-ethyl-urethan; *syn.*, ...Euphorin.
Saccharin; *syn.*, ...Garanotose.
Subgallate of Bismuth; *syn.*, ...Dermatol.
Sodium chlorate; *syn.*, ...Oxychlorin.
Sodium beta-naphtholate; *syn.*, ...Microcidin.
Tang-Ki, Fl'ext.; *syn.*, ...Eumenol.
Trichloracetic Acid (50 per cent. solution); *syn.*, Acetocaustic.

CONSPECTUS A.—OFFICIAL DRUGS ARRANGED ACCORDING TO STRUCTURAL CHARACTERISTICS.

SYNOPSIS OF CLASSIFICATION.

VEGETABLE.

I. PHANEROGAMS:
- A. *Subterranean or Underground Organs*—
  1. Roots.
  2. Rhizomes.
  3. Tubers.
  4. Bulbs.
  5. Corms.
- B. *Overground Stems*—
  - α. Herbaceous.
    6. Herbs.
  - β. Woody.
    7. Barks.
    8. Twigs.
    9. Woods.
    10. Piths.
- C. *Outgrowths from Overground Stems*—
  11. Leaves.
  12. Leafy tops.
  13. Plant hairs and glandular outgrowths.
  14. Flowers and parts of flowers.
  15. Fruits and parts of fruits.
  16. Seeds and seed coverings.

II. CRYPTOGAMS.
- A. *Equisetaceæ.*
- B. *Filices.*
- C. *Lycopodiaceæ.*
- D. *Lichenes.*
- E. *Fungi*
- F. *Algæ.*

III. ABNORMAL GROWTHS CAUSED BY PARASITES.
- A. *Excrescences.*

IV. NON-CELLULAR DRUGS DERIVED FROM CELL-CONTENTS AND SECRETIONS.
- A. *Farinaceous.*
- B. *Extractives.*
- C. *Concrete juices.*
- D. *Sugars.*
- E *Gums.*
- F. *Gum resins.*
- G. *Resins.*
- H. *Oleoresins.*
- I. *Balsams.*
- J. *Stearoptens.*
- K. *Fatty substances.*

ANIMAL.

I. INSECTS.
II. TISSUES AND SECRETIONS.

DERIVED FROM THE VEGETABLE KINGDOM.

(With Brief Description.)

I. PHANEROGAMS.

A. Subterranean or Underground Organs.

I. ROOTS.

(*a*) Monocotyledonous Roots:

Orange, brown, thick, mealy or horny cortical layer, separated from the wood-bundles by the nucleus sheath; broad central pith, ... **Sarsaparilla, 547**

(*b*) Dicotyledonous Roots:

a. Fleshy, with thin bark.

In transverse slices;* externally grayish-brown; twisted and irregularly matted wood fibers; light and spongy meditullium, **Sumbul, 247**

Irregular pieces; reddish-yellow; narrow medullary rays, producing mottled appearance (rhizome, U. S. P. 1900), ... **Rheum, 449**

Externally grayish; fibrous; small, narrow, radiating wood-bundles in concentric circles, ... **Phytollacca, 447**

With thick bark.

Subcylindrical, grayish-brown, narrow wood-wedges and medullary rays; porous meditullium, ... **Stillingia, 483**

White; wood-bundles small, scattered; narrow medullary rays, **Althea, 66**

Externally dull gray; wood-bundles near the center small and scattered; distinct cambium, ... **Belladonna, 386**

Yellowish Brown. See *Rhizomes, Scopola*, ... 388

In sections, externally brown; small, yellow wood-bundles, radiate near the bark; dark cambium, ... **Calumba, 22**

Gray-brown; white bark, containing numerous concentric circles of lacitiferous vessels; yellow, woody center, .. **Taraxacum, 275**

Sometimes sliced longitudinally; gray-brown, internally lighter; meditullium spongy; radiate, with broad medullary rays, **Lappa, 280**

Hard, somewhat fusiform, brownish; wood-wedges and medullary rays narrow, radiate; resin ducts in circles, ... **Pyrethrum, 277**

Sometimes in longitudinal slices; yellowish-brown; meditullium spongy; medullary rays indistinct; distinct cambium (root and rhizome), ... **Gentian, 372**

Yellowish-gray, keeled when dry; wood porous; fine medullary rays; whitish inner bark excessively developed on one side, **Senega, 53**

b. Woody, with thin bark.

Generally in sections; brownish-yellow, with purplish longitudinal lines; thin cork; porous wood-wedges; broad medullary rays (root and rhizome), ... **Gelsemium, 369**

Rust-brown; thick cork; very narrow medullary rays (very astringent), ... **Krameria, 52**

Tortuous, subcylindrical pieces; wood-wedges arranged in concentric circles, separated by compressed stone cells, .. **Pareira, 23**

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* When not otherwise stated, roots in this list are cylindrical in form.

With thick bark.

Brownish color, internally tawny yellow, thin cork; narrow wood-wedges; distinct medullary rays, ... **Glycyrrhiza,** 133

Light brown; wood porous; thin cork; numerous narrow medullary rays (rhizome, U. S. P. 1900), ... **Apocynum,** 352

Blackish color; thick bark; meditullium radiate, distinct medullary rays, ... **Ipecac,** 265

2. RHIZOMES.

(*a*) MONOCOTYLEDONOUS:

a. With rootlets.

Obconical, but usually in slices; internally whitish, with dark dots; wood bundles short, curved, inclosed by wavy nucleus sheath; benumbing, acrid, bitter taste, **Veratrum Viride, and V. Album,** 549

Whitish, irregular pieces; parenchyma thin-walled; small number of vascular bundles within a thick-celled nucleus sheath, **Convallaria,** 548

Brownish color; deep stem scars on upper side; rather thick bark; wood-bundles scattered, distinct toward the center; nucleus sheath indistinct, ... **Cypripedium,** 531

b. Without rootlets.

Buff color; flattish, lobed on one side; resin cells scattered through the parenchyma; wood-bundles both sides the nucleus sheath, **Zingiber,** 535

Red-brown, pinkish-white when peeled; bark thick; spongy meditullium containing air-cells; vascular bundles most numerous near the nucleus sheath, ... **Calamus,** 568

Light yellow, straw-like, hollow; cortical zone thick, composed of large-celled parenchyma, and containing about six wood-bundles near the outer surface, ... **Triticum,** 575

(*b*) DICOTYLEDONOUS RHIZOMES:

a. With rootlets.

Brown; thin bark covered with a thin cork; vascular bundles small, inclosing a thick pith; odor disagreeable, . . **Valerian,** 274

Yellow-brown; bark thin; wood-wedges largest on the lower side; large-celled pith near top of rhizome, . . . **Serpentaria,** 547

Internally bright reddish-yellow; thick bark; narrow wood-wedges; broad yellow medullary rays, inclosing large pith, **Hydrastis,** 2

Brownish black, internally whitish; thick bark; narrow wood-wedges and medullary rays; large pith; wood-wedges of the rootlets form "Maltese cross," .... **Cimicifuga,** 1

Blackish-brown; bark thin; wood in one or two circles, inclosing a large, angular pith, usually about six-rayed, . . **Leptandra,** 403

Purplish-brown; bark thin; wood whitish, and arranged in a circle, thickest on lower side; pith dark-colored or decayed, **Spigelia,** 370

Yellowish-brown; tough (root and rhizome), ... **Berberis,** 31

b. Without rootlets.

Orange-brown; bark thick; wood-wedges short, forming a circle and inclosing a large pith, ... **Podophyllum,** 27

Yellowish-brown to dark brownish gray, indistinctly radiate wood, horny center, ... **Scopola,** 388½

Reddish-brown; internally whitish, usually with small red dots; bark thin; small vascular bundles in loose circle; large pith; numerous resin cells in parenchyma, ... **Sanguinaria,** 39

Brown, internally brownish-red; thin bark; wood-wedges small, forming distinct circles near cambium; medullary rays broad; large central pith, ... **Geranium,** 77

Aspididium, Male Fern Rhizome. (See *Cryptogams, II*), 583

3. TUBERS.

(*a*) Dicotyledonous:

Dark brown, with lighter colored warts; bark thin, with a dense zone of resin cells on the inner surface; vascular bundles small and indistinct, concentric circles of resin cells, ... **Jalapa,** 383

Dark brown, wrinkled; thick bark; cambium about seven-rayed; small vascular bundles at termination and base of cambium rays; large-celled pith (tuberous root), ... **Aconitum,** 14

4. BULBS.

(*a*) Monocotyledonous:

Pear-shaped, yellow-white; usually in scales; parenchyma thin-walled, with numerous raphides, and traversed by parallel vascular bundles and lactiferous ducts, ... **Scilla,** 556

5. CORMS.

(*a*) Monocotyledonous:

Ovoid, with groove on one side, often in transverse slices; uniform in shape; mostly parenchymatous tissue, containing occasional raphides; vascular bundles numerous, scattered, **Colchici Cormus,** 219

B. Overground Stems.

a. HERBACEOUS.

6. HERBS.

(*a*) Dicotyledonous:

a. Petals distinct.

Leaves small, trifoliate; stems pentangular, nearly smooth; as found in market, drug consists mostly of the greenish-brown stems, free from leaves (tops of the plant), ... **Scoparius,** 148

b. Petals united.

Leaves opposite, lanceolate, united at base; the drug consists of broken fragments of dark green leaves, with downy, resin-dotted, lower surface, ... **Eupatorium,** 296

Leaves smooth, light green; florets yellow; the drug consists of fragments of leaves, stems, and flower-heads with stiff, resinous bracts, ... **Grindelia,** 298

Leaves ovate, alternate, pale green; stems furrowed, hairy; flowers small, pale blue; capsules thin and papery, **Lobelia,** 327

Leaves petiolate, ovate-lanceolate, sharply serrate; flowers purplish, in terminal, conical spikes, ... **Mentha Piperita,** 415

Leaves nearly sessile, lance-ovate; flowers in terminal acute spikes, aromatic, ... **Mentha Viridis,** 416

Leaves opposite, oblong-ovate; flowers small; axillary cymules, aromatic, ... **Hedeoma,** 417

Leaves long, opposite, roundish-ovate, white and hairy beneath; flowers dense, axillary whorls, ... **Marrubium,** 418

Leaves opposite, petiolate, lance-ovate, serrate; flowers axillary, one-sided racemes; stem quadrangular, smooth, **Scutellaria,** 420

c. Petals absent.

Leaves opposite, sessile, ovate; flowers numerous, small; whole plant smooth, pale brown, inodorous, ... **Chirata**, 374

Leaves digitate, with lancelinear leaflets; the drug in market consists of leafy tops and flowers, often contains nearly ripe fruit, all forming brownish-green, resinous mass. **Cannabis Indica**, 498

β. WOODY.

7. BARKS.

(*a*) Bast with Isolated Bast Cells:

Bast fibers short, in radial lines or small groups; inner bark reddish-brown, finely striate; cork cells thin-walled, **Cinchona**, 267

(*b*) Bast Radially Striate:

Long, closely rolled quills composed of many papery, yellowish-brown layers; smooth outer surface composed of stone cells; wood-bundles in wavy lines; no outer bark, **Cinnamomum Zeylanicum**, 467

Corky layer present, gray-brown with numerous white patches on the surface; an almost uninterrupted line of white striæ near cork, ... **Cinnamomum Saigonicum**, 469

Irregular fragments, deprived of gray corky layer; bright rust brown; bast fibers few; light medullary rays in inner layer, **Sassafras**, 470

Irregular pieces; periderm greenish-brown, glossy; inner surface lighter, finely striate; bast wavy, irregular, **Prunus Virginiana**, 166

(*c*) Bast Tangentially Striate:

Long, thin bands rolled into disks; periderm greenish-orange; inner surface white, silky; bast fibers long; bark flexible, **Mezereum**, 480

Thin, tough bands; periderm blackish; inner surface lighter, smooth; bast fibers in elongated wedge-shaped groups, **Rubus**, 180

Thin, flexible quills or bands; periderm thin, yellow-brown; inner surface white, finely striate; bast fibers long, silky, **Gossypii Cortex**, 69 a

Quilled or curved pieces; periderm ash-gray, covered with blackish patches; scaly; inner surface smooth, tawny, **Euonymus**, 112

Flattish or curved bands; periderm brown-gray, covered with elongated brownish warts; inner surface white or brownish, **Viburnum Opulus**, 262

(*d*) Bast Checkered:

Brownish-white pieces, nearly deprived of corky layer; bast fibers in rows, crossed by numerous medullary rays; mucilaginous, **Ulmus**, 495

Pale brown pieces, deprived of corky layer; inner surface ridged; astringent, ... **Quercus**, 505

Pale brown-white pieces; smooth on both sides or outer surface with fragments of red-brown bark; bast fibers pale brown, imbedded in white wood and crossed by white medullary rays, **Quillaja**, 175

(*e*) Bast without Striation:

Thin quills or fragments; outer surface dark brown, somewhat warty; inner surface yellowish, finely striate, . . . **Granatum**, 211

Thin pieces; periderm glossy brown, dotted; inner surface whitish, smooth; numerous groups of stone cells, **Viburnum Prunifolium,** 263

Thin quills; periderm dark brown with white dots; inner surface smooth, brownish-yellow; rows of crystal cells, . . **Frangula,** 114

Curved or quilled pieces, outer surface brown-gray; inner surface yellowish, darkening with age; finely striate; bast bundles in groups; medullary rays narrow, ... **Rhamnus Purshiana,** 115

Curved fragments; periderm brownish gray, with black dots; inner surface whitish, smooth; medullary rays narrow, **Xanthoxylum,** 81

8. TWIGS.

Greenish-gray; bark rather thick; wood in one or two circles (U. S. P , 1890), ... **Dulcamara,** 396

9. WOODS.

Yellowish-white billets; free from bark; consists mostly of prosenchyma, with large ducts, radially striate; narrow medullary rays; very bitter, ... **Quassia,** 96

Wood dark rēd; parenchyma in about four rows, forming irregular circles; medullary rays single-rowed; ducts large, **Santalum Rubrum,** 142

Brownish-red; wood parenchyma in broad, wavy circle; medullary rays composed of about two rows of cells; ducts fine, **Hæmatoxylon,** 141

10. PITHS.

Cylindrical, white, very light and spongy, **Sassafras Medulla,** 472

C. Outgrowths from Overground Stems.

11. LEAVES.

(*a*) SIMPLE:

a. Margin entire.

Gray-green, lanceolately scythe-shaped, distinct marginal veins, coriaceous, feather-veined, ... **Eucalyptus,** 204

Dark green, obovate; midrib prominent, with a curved line on each side, ... **Coca,** 74

Brownish-green above, pale below, ovate, tapering at the apex; midrib prominent, smooth with occasional perforations, **Belladonnæ Folia,** 387

Gray-green below, rather thick, obovate; smooth, dark-green, glossy above; lighter and reticulate below, ... **Uva Ursi,** 328

b. Margin toothed or crenate.

Ovate-oblong, gray-green; veining prominent; soft, hairy, aromatic, ... **Salvia,** 434

Lanceolate; upper surface dull green, tesselated; under surface rough, prominently veined, meshed, ... **Matico,** 460

Obovate, dull yellowish-green, coriaceous, pellucid-punctate, sharply serrate, with gland at the base of each tooth, **Buchu,** 83

Oblong-lanceolate; upper surface varnished, brownish-green; under surface white, hairy, distinctly reticulate, **Eriodictyon,** 377

Ovate-oblong; upper surface green, wrinkled, velvety; under surface hairy, prominent whitish meshes, ... **Digitalis,** 400

Ovate-oblong, with large triangular crenations; gray-green, hairy; midrib prominent, lighter colored; odor heavy, narcotic, **Hyoscyamus,** 391

Ovate, with sharp-pointed teeth; smooth, brownish-green; midrib hairy, ... **Stramonium,** 389

Oblanceolate, coriaceous, sharply serrate; upper surface dark green, smooth, ... **Chimaphila,** 331

Ovate, nearly smooth, veins parallel from the midrib, **Hamamelidis Folia,** 199

(*b*) COMPOUND:

a. Margin entire.

Ovate, coriaceous, dull green; veins forming one or two wavy lines parallel to the margin, ... **Pilocarpus,** 84

Lance-oval, gray-green, somewhat pubescent, odor peculiar, nauseous, ... **Senna (Alexandria),** 143

12. LEAFY TOPS.

Branches quadrangular; leaves in four rows, scale-like, imbricated, with shallow groove on the back, ... **Sabina,** 516

13. PLANT HAIRS AND GLANDULAR OUTGROWTHS.

Subglobular, minute, yellowish-brown granules; resinous; under the microscope, hood-shaped, ... **Lupulinum,** 497

Fine powder, pale yellow, not wetted by water; under the microscope, tetrahedral, ... **Lycopodium,** 582

Hairs of seed long, white (see seed covering), . . . **Gossypium,** 69 b

Styles and stigmas, fine silky hairs (see also seed coverings), **Zea,** 578

14. FLOWERS AND PARTS OF FLOWERS.

(*a*) FLOWERS AND BUDS:

a. Racemose or cymose inflorescence.

Sepals five, reddish, veined; petals small, hairy, ... **Cusso,** 185

b. Compound flower-heads.

Oblong-ovoid, unexpanded, small; smooth, somewhat glossy, greenish-brown scales, ... **Santonica,** 323

Petals united; rays long, white; disk-flowers numerous, short, yellow, tubular; receptacle hollow, naked, ... **Matricaria,** 321

Petals united; rays white, in rows; flower-heads large; receptacle solid, densely chaffy; disk florets few, yellow, tubular, **Anthemis,** 322

Petals united; rays yellow, strap-shaped, longitudinally veined; receptacle flat, naked; disk florets yellow, tubular, **Calendula,** 324

Petals united; rays yellow, three-toothed; flower-heads large; receptacle nearly flat, pitted, hairy, ... **Arnica,** 287

c. Single flowers.

Unexpanded; long, dark brown; calyx four-cleft, solid, glandular; petals four, formed into a head; aromatic, **Caryophyllus,** 207

(*b*) PETALS.

Petals unexpanded; in form of cone; deep-red, yellow at base; fragrant, ... **Rosa Gallica,** 176

(*c*) STIGMAS:

Thread-like, long, silky, longitudinally veined, yellowish; with styles, ... **Zea,** 578

15. FRUITS AND PARTS OF FRUITS

(*a*) Collective Fruits:

Strobiles glandular; thin, greenish scales, with delicate veins; aromatic, ... **Humulus,** 496

Fleshy compressed; yellowish or brownish; efflorescence of sugar; numerous yellow akenes; sweet, ... **Ficus,** 500

(*b*) Fruits from Single Flowers:

a. Cremocarps.

Ovate, compressed at the sides, grayish, hairy, mericarps usually separated, curved, five-ribbed; many thin oil tubes; aromatic, sweet, ... **Anisum,** 228

Ovate, compressed, gray-green, smooth; mericarps usually separated, each five-ribbed; six oil tubes, ... **Carum,** 232

Oblong, smooth, nearly cylindrical, greenish-brown; ribs prominent, obtuse, ten oil tubes, ... **Fœniculum,** 229

Globular, smooth; mericarps united, each with two oil tubes on face and five wavy ribs and four prominent ridges on back, **Coriandrum,** 233

b. Capsular fruit, superior.

Cylindrical, long, black-brown; numerous transverse divisions; seeds glossy brown; pulp sweet, odor prune-like, **Cassia Fistula,** 149

Inferior.

Ovate-triangular, three-celled; pale buff color; seeds brownish, angular, numerous, ... **Cardamomum,** 539

Cylindrical, long, wrinkled, single-celled, containing the numerous small black seeds; pulp blackish-brown; fragrant, **Vanilla,** 534

c. Fleshy.

Globular, blackish-gray, reticulately wrinkled; internally whitish, hollow; pericarp formed into a stalk, ... **Cubeba,** 456

Globular, brownish-black; internally lighter, hollow; reticulately wrinkled; without stalk, hot taste, ... **Piper,** 457

Globular, glandular; two-celled; each cell contains a single brownish seed; aromatic, ... **Pimenta,** 208

Subglobular, dark red, densely hairy, single-seeded, **Rhus Glabra,** 127

Blackish-brown, one seeded, ovoid-oblong, ... **Sabal,** 563

Oblong, wrinkled; pericarp red, shining; two-celled; with numerous yellowish seeds; intensely hot taste, ... **Capsicum,** 398

Globular, deprived of rind; light, spongy, breaking into thin, wedge-shaped pieces; contains many light-colored seeds; intensely bitter, ... **Colocynthis,** 219

Oblong, wrinkled, black-blue; pulp soft, brownish-yellow; single seed; sweet, acidulous, ... **Prunum,** 168

(*c*) Parts of Fruits:

Thin, curved sections; glandular; pericarp leathery, dark brownish-green; odor fragrant, ... **Aurantii Cortex,** 87

Thin curved sections; glandular; epidermis deep lemon-yellow; odor fragrant, ... **Limonis Cortex,** 92

Pulp fibrous, dark brown, sweet, acidulous, with glossy brown, flattish seeds, ... **Tamarindus,** 157

16. SEEDS AND SEED COVERINGS.

α. SEEDS.

(a) DICOTYLEDONOUS:

a. Albuminous.

Orbicular disks, grayish-green, curved, with fine, silky hairs; internally whitish, hairy; bitter taste, ... **Nux Vomica,** 336

Ovate; testa removed; hard, light brown, reticulately furrowed; internally lighter, with dark brown veins; strongly aromatic, **Myristica,** 465

Ovate-lanceolate; flattish, hairy, gray-green; internally white, oily, ... **Strophanthus,** 357

Triangular, flattish, brown, deeply pitted; albumen whitish, oily, **Staphisagria,** 11

Ovate, flattish; testa brown, glossy; albumen thin, inclosing large cotyledons, ... **Linum,** 73

b. Exalbuminous.

Ovate, flattish, curved, with a thin, brown, membranous testa; longitudinally veined; embryo white, oily, consists of two planoconvex cotyledons; bitter taste, ... **Amygdala Amara,** 172

Resembles above, but longer, more convex sides; a bland, sweetish taste, ... **Amygdala Dulcis,** 173

Globular, small; testa dark brown, hard, finely pitted; embryo greenish-yellow, oily; pungent taste, ... **Sinapis Nigra,** 43

Globular, larger than above; testa yellowish; taste pungent, **Sinapis Alba,** 42

Ovate, broad, flat; testa whitish; shallow groove and flat ridge near margin, ... **Pepo,** 222

Oblong or reniform; testa deep brown, granular; broad black groove along convex edge; elliptic cavity between cotyledons, **Physostigma,** 154

(b) MONOCOTYLEDONOUS:

a. Albuminous.

Subglobular; testa reddish-brown, thin, pitted, hard; albumen whitish, tough, horny, ... **Colchici Semen,** 558

β. SEED COVERINGS.

(a) ARILLODE:

(b) SEED HAIRS:

Hairs of seeds long, white, curling, . . **Gossypium Purificatum,** 69 b

II. CRYPTOGAMS.

A. Filices.

Rhizome, with glossy brownish scales, ... **Aspidium,** 583

B. Algæ.

Yellow, horny, transparent, with numerous forks and branches; mucilaginous taste, ... **Chondrus,** 596

C. Lichens.

Brownish above, whitish beneath; foliaceous (U. S. P., 1890), **Cetraria,** 590

D. Fungi.

Oblong, narrow, curved; longitudinally grooved; black; peculiar heavy odor, ... **Ergota,** 592

E. Club Mosses.

Fine powder, pale yellow, very mobile, floats on water; under the microscope, tetrahedral. (See also under 13), **Lycopodium,** 588

III. ABNORMAL GROWTHS CAUSED BY PARASITES.

A. Excrescences.

Globular, with a short stipe; externally dull blue or lead color, covered with prominent warts, interior whitish, central cavity, **Galla**, 508

IV. NON-CELLULAR DRUGS DERIVED FROM CELL-CONTENTS AND SECRETIONS.

A. Farinaceous.

Fine, white powder, sometimes in angular masses; odorless and tasteless; insoluble in cold water, ... **Amylum**, 580

B. Extractives.

Irregular masses containing fragments of leaves; dark brown; fracture conchoidal, brittle, glossy (Gambir), ... **Catechu**, 159

Cylindrical cakes, hard, mottled, reddish-brown; fracture uneven, lighter colored, ... **Guarana**, 121

Cylindrical sticks, glossy brown-black; fracture conchoidal; taste sweet, ... **Extractum Glycyrrhizæ**, 134

C. Concrete Juices.

Irregular masses containing some fragments of leaves; chestnut-brown, plastic, coarsely granular; odor heavy; narcotic, **Opium**, 34

Angular pieces, red-brown; internally lighter; waxy lustre; bitter, **Lactucarium**, 316

Yellowish to blackish masses, hard, brittle, somewhat glossy; taste bitter, ... **Aloe**, 559

Small angular pieces, brittle, dark brownish-red; thin layers, ruby-red and transparent; sweetish, ... **Kino**, 160

Flat pieces, blackish-brown, internally lighter; very elastic; floats on water, ... **Elastica**, 488

D. Sugars.

(*a*) SOLID:

Granular, white, crystalline, transparent, very sweet, very soluble in water, ... **Saccharum**, 577

Crystals or white crystalline powder, gritty; translucent, sandy; sweetish taste, ... **Saccharum Lactis**, 617 d.

Irregular fragments; light yellow; internally white; porous, crystalline, friable, sweet, ... **Manna**, 346

(*b*) LIQUID:

Translucent syrup, yellow to brown-yellow, ... **Mel**, 612

E. Gums.

Roundish tears, fissured, brittle, translucent; fracture glass-like, **Acacia**, 157

Curved bands, marked with parallel wavy lines; white, translucent, tough, horny, ... **Tragacantha**, 158

F. Gum Resins.

Irregular pieces composed of whitish tears imbedded in a brown-gray, sticky mass; odor sickening, ... **Asafœtida**, 244

Irregular masses or tears; red-brown, dusty; fracture waxy; taste bitter, acrid, ... **Myrrha**, 102

Cylindrical pieces or lumps, sometimes hollow in the center; orange-yellow; fracture smooth, waxy, ... **Cambogia**, 61

Irregular pieces or circular cakes; dark gray internally; porous; fracture angular; odor peculiar, somewhat cheese-like, **Scammonium**, 385

G. Resins.

Irregular lumps; reddish-brown, smooth, mottled, with milk-white tears; agreeable balsamic odor, ... **Benzoinum**, 345

Large lumps or masses, yellowish-brown, transparent, brittle, **Resina**, 522 c

Small globular tears, transparent, yellowish, brittle, glossy, **Mastiche**, 129

Irregular masses, greenish or reddish-brown; internally of a glossy luster; brittle, ... **Guaiacum**, 67

H. Oleoresins.

Brownish-yellow, viscid liquid; transparent; odor peculiar; taste bitter, ... **Copaiba**, 161

Light yellow or faintly greenish, transparent or viscid liquid; agreeable odor, ... **Terebinthina Canadensis**, 524

Irregular masses, tough, yellowish, opaque; fracture crumbly, **Terebinthina**, 522

Thick, viscid semi-fluid, nearly black, opaque; odor empyreumatic, **Pix Liquida**, 523

I. Balsams.

Thick, syrupy liquid; brownish-black, thin layers, transparent, **Balsamum Peruvianum**, 164

Very thick semi-liquid, brownish-yellow, solid in the cold, agreeable odor, ... **Balsamum Tolutanum**, 165

Viscid semi-liquid, opaque, brownish-gray, odor agreeably balsamic, ... **Styrax**, 201

J. Stearoptens.

Translucent masses; tough, crystalline, granular; odor penetrating, peculiar, ... **Camphora**, 478

Colorless prisms or small scales; thyme-like odor, ... **Thymol**, 237

Fine, white transparent needles or crystals; peppermint odor, **Menthol**, 415 b

K. Fatty Substances.

(*a*) Of Vegetable Origin:

Straw-colored liquid; clear, rather thin; nutty odor, bland taste, **Oleum Amygdalæ Expressum**, 174

Yellow, limpid liquid; transparent, ... **Oleum Lini**, 73 a

Viscid, yellowish, nearly colorless, transparent; taste sickening, **Oleum Ricini**, 492

Viscid, yellow to brownish, transparent, somewhat fluorescent; taste acrid, burning, ... **Oleum Tiglii**, 492 a

Pale yellow liquid; thin, transparent; odor and taste mild nutty, **Oleum Gossypii Seminis**, 69 c

Yellow to greenish-yellow, thin, clear, ... **Oleum Olivæ**, 347

Yellowish-white solid; rather hard, brittle, aromatic; taste chocolate-like, ... **Oleum Theobromatis**, 71 a

(*b*) Of Animal Origin:

Pale yellow liquid; thin, transparent; fishy odor, **Oleum Morrhuæ**, 610

Yellowish, nearly colorless; thin, clear, ... **Oleum Adipis**, 622 a

Soft, white solid; unctuous, ... **Adeps**, 622

Light yellow or whitish solid, rather firm, **Adeps Lanæ Hydrosus**, 625

White solid; smooth, unctuous, ... **Sevum Præparatum**, 620

(*c*) Waxes:

White masses; translucent; fracture crystalline, .. **Cetaceum**, 611

Yellowish-white cakes; brittle; semi-translucent,
Cera Alba, 612 b

Yellow to brownish, opaque; fracture granular,
Cera Flava, 612 a

(*d*) Mixture of Hydrocarbons, 625 a
Petrolatum Album, Petrolatum Liquidum, **Petrolatum** = Petrolatum Molle, Petrolatum Spissum, Paraffinum.

DRUGS OF ANIMAL ORIGIN.

A. INSECTS.

Long, bronze-green; body cylindrical; head triangular,
Cantharis.

Oval, gray or brownish, wrinkled, covered with a whitish down,
Coccus.

B. TISSUES AND SECRETIONS.

Granular, crumbly, various sizes; dark reddish-brown; peculiar penetrating odor, ...**Moschus.**

Viscid liquid, of a brownish or dark green color,.......**Fel Bovis.**

Yellowish-green solid, rather soft,.........**Fel Bovis Purificatum.**

Yellowish powder or thin, yellow, translucent scales,..**Pepsinum.**

Yellowish-white powder or transparent, brittle scales,
Pancreatinum.

(Fatty substances of animal origin. See above under K (*b*), Adeps etc.)

BACTERIAL PRODUCTS.

Antitoxic Serums, 629
Serum Antidiphtheriticum, 629 (a)

GLANDULAR PRODUCTS.

Glandulæ Suprarenales Siccæ, 629
Glandulæ Thyreoideæ Siccæ, 630

CONSPECTUS B.—OFFICIAL AND UNOFFICIAL DRUGS, ARRANGED ACCORDING TO PROMINENT PHYSICAL PROPERTIES, AND SUBDIVIDED BY ODOR AND TASTE.

(*With Natural Order or Family, and Official Preparations.*)

ROOTS.

CLASS I.—AROMATIC.

(*a*) **Odor and Taste Pronounced.**

SUMBUL.—Musk Root. 247.* Umbelliferæ. Fl'ext
Angelica.—Angelica. 243. Umbelliferæ.
Angelica Atropurpurea.—American Angelica. 242. Umbelliferæ.
**Armoracia*—Horse-radish. 45. Cruciferæ.
Imperatoria.—Masterwort. 248. Umbelliferæ.

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* The names in italics refer to unofficial drugs; some of these (marked thus, *) have been official in one or more of the former editions of the U. S. P. The numbers correspond to the numbers of the drugs in the body of this work.

Levisticum.—Lovage. 250. Umbelliferæ.
Pimpinella.—Pimpernel. 251. Umbelliferæ.
Vetiveria.—Vetivert. 576. Gramineæ.

(*b*) **Feebly Aromatic.**
GELSEMIUM.—Yellow Jasmine. 369. Loganiaceæ Fl'ext., tr.
**Inula.*—Elecampane. 279. Compositæ.
Methysticum.—Kava Kava. 463. Piperaceæ.
**Petroselinum.*—Parsley. 238. Umbelliferæ.

CLASS II.—ODORLESS AND TASTELESS.

Alkanna.—Alkanet. 379. Boraginaceæ.

CLASS III.—ACRID.

(*a*) **Acridity Pronounced.**
PHYTOLACCÆ RADIX.—Poke Root. 447. Phytolaccaceæ. Fl'ext.
PYRETHRUM.—Pellitory. 277. Compositæ. Tr.
SARSAPARILLA.—547. Liliaceæ. Fl'ext., co. fl'ext., co. syr.
SENEGA.—Seneka. 53. Polygalaceæ. Fl'ext , syr., co. syr. squill.
STILLINGIA.—Queen's Delight. 483. Euphorbiaceæ. Fl'ext.
Pyrethrum Germanicum.—277 a. Compositæ.

(*b*) **Acridity Slight.**
BELLADONNÆ RADIX.—Deadly Nightshade. 386. Solanaceæ. Fl'ext., liniment.
**Euphorbia Corollata.*—Large Flowering Spurge. 484 a. Euphorbiaceæ.
**Euphorbia Ipecacuanha.*—Ipecacuanha Spurge. 484 b Euphorbiaceæ.
Hemidesmus.—Indian Sarsaparilla. 364. Asclepiadaceæ.
Scopola.—See *Rhizomes.*

CLASS IV.—BITTER.

APOCYNUM.—Canadian Hemp. 352. Apocynaceæ. Fl'ext.
**Asclepias.*—Pleurisy Root. 360. Asclepiadaceæ. Fl'ext.
**Bryonia.*—Bryony. 218. Cucurbitaceæ. Tr.
CALUMBA.—Columbo. 22. Menispermaceæ. Fl'ext., tr.
GENTIANA.—372. Gentianacæ. Fl'ext., co. tr., ext.
IPECACUANHA.—Ipecac. 265. Rubiaceæ. Fl'ext., syr., wine, pulv. ipecac. et opii.
PAREIRA.—Pareira Brava. 23. Menispermaceæ. Fl'ext.
RHEUM.—Rhubarb. 449. Polygonaceæ. Fl'ext., tr., ext., arom. tr., syr., arom. syr., co. pil., co. powd., mixt. r. et sodæ.
**Rumex.*—Yellow Dock. 450. Polygonaceæ. Fl'ext.
TARAXACUM.—Dandelion. 275. Compositæ. Fl'ext., ext.
**Apocynum Androsæmifolium.*—Dog's Bane. 352 a. Apocynaceæ.
Baptisia.—Wild Indigo. 136. Leguminosæ.
BERBERIS.—Oregon Grape (root and rhizome). 31 Berberidaceæ.
**Berberis.*—Barberry. 29. Berberidaceæ
Cichorium.—Chicory. 276. Compositæ.
**Frasera.*—American Columbo. 373. Gentianaceæ.
Rhaponticum.—Crimean Rhubarb. 449 a. Polygonaceæ.

CLASS V.—SWEETISH.

GLYCYRRHIZA.—Licorice Root. 133. Leguminosæ. Fl'ext., ext., pure ext., co. powd., co. mixt., mass. hg., pil. iod. iron, co. morph. powd., co. syr. sars., ammon. glycyrr., troch. g. et opii, troch. ammon. chlor., tr. aloes et myrrh. Also in a number of the fluid extracts.
Ipomæa Pandurata.—Wild Jalap. 384. Convolvulaceæ.
**Panax.*—Ginseng. 256. Araliaceæ.
Saponaria.—Soapwort. 57. Caryophyllaceæ.
Saponaria Levantica.—56. Caryophyllaceæ

CLASS VI.—MUCILAGINOUS.

ALTHÆA.—Marshmallow. 568. Malvaceæ. Mass. hg., pil. phosphor., pil. ferri carb.
LAPPA.—Burdock. 280. Compositæ. Fl'ext.
Symphytum Comfrey.—380 Borraginaceæ.

CLASS VII.—ASTRINGENT.

KRAMERIA.—Rhatany 52. Krameriaceæ. Fl'ext., tr., ext., syr., troch.
**Heuchera.*—Alum Root. 193. Saxifragaceæ.
**Statice.*—Marsh Rosemary. 338. Plumbaginaceæ.

UNCLASSIFIED.—All unofficial: Abri Radix, 134. Baycuru, 339. Carnauba, 564. Ceanothus, 117. Cicuta, 253. Echinacea, 285. Eryngium, 254. Helianthella, 284. Hydrangea, 194. Jambu Assu, 462. Laciniaria, 283. Laserpitium, 249. Manaca, 388. Maregamia, 106. Osmorrhiza, 255. Osmunda, 588. Pæonia, 16. Polemonium, 378. Polymnia, 282. Thapsia, 252. Triosteum, 264. Verbena Hastata, 412 Verbena Urticæfolia, 413. Yerba Mansa 461.

RHIZOMES.

CLASS I.—AROMATIC.

(*a*) **Odor and Taste Pronounced.**
CALAMUS.—Sweet Flag. 568. Araceæ. Fl'ext.
SERPENTARIA.—Virginia Snakeroot. 454. Aristolochiaceæ. Fl'ext., tr., tr. cinch. co.
VALERIANA.—Valerian. 274. Valerianaceæ. Fl'ext., tr., ammon. tr.
ZINGIBER.—Ginger. 535. Zingiberaceæ. Fl'ext., tr., syr., oleores., arom. powd., co. rhub. powd., arom. sulphur. acid.
**Asarum.*—Wild Ginger. 455. Aristolochiaceæ.
Galanga.—Galangal. 536. Zingiberaceæ.
Zedoaria.—Zedoary. 537. Zingiberaceæ.

(*b*) **Slightly Aromatic.**
**Arnicæ Radix.*—286. Compositæ.
**Aralia Nudicaulis.*—False Sarsaparilla. 257. Araliaceæ.
Aralia Racemosa.—American Spikenard. 257 a. Araliaceæ.
**Curcuma.*—Turmeric. 538. Zingiberaceæ.
**Iris Florentina.*—Orris Root. 544. Irideæ

CLASS II.—ACRID.

**Iris.*—Blue Flag. 543. Iridaceæ. Fl'ext., ext.
SANGUINARIA.—Bloodroot. 39. Papaveraceæ. Fl'ext., tr.
VERATRUM VIRIDE OR ALBUM.—American (green) or European (white) Veratrum. 549. Liliaceæ. Fl'ext., tr.
Dioscorea.—Wild Yam. 546. Dioscoreaceæ.
Symplocarpus.—Skunk Cabbage. 569. Araceæ.
Trillium.—Birthwort. 553. Liliaceæ.

CLASS III.—SLIGHTLY ACRID AND BITTER.

CIMICIFUGA.—Black Snakeroot. 1. Ranunculaceæ. Fl'ext., tr., ext.
CONVALLARIA.—Lily of the Valley. 548. Liliaceæ. Fl'ext.
CYPRIPEDIUM.—Lady's Slipper. 531. Orchidaceæ. Fl'ext.
PODOPHYLLUM.—Mandrake. 27. Berberidaceæ. Fl'ext., resin.
SCOPOLA.—Solanaceæ. Ext.
**Caulophyllum.*—Blue Cohosh. 26. Berberidaceæ.

Asclepias Cornuti.—Milk-weed. 361. Asclepiadaceæ.
**Asclepias Incarnata.*—Swamp Milkweed. 362. Asclepiadaceæ.
**Helleborus Niger.*—Black Hellebore. 5. Ranunculaceæ.
Helleborus Viridis.—Green Hellebore. 6. Ranunculaceæ.
Polygonatum.—Solomon's Seal. 551. Liliaceæ.

CLASS IV.—BITTER.

(*a*) **With Rootlets.**

HYDRASTIS.—Golden Seal. 2. Ranunculaceæ. Fl'ext., tr., glycerite.
LEPTANDRA.—Culver's Physic. 403. Scrophulariaceæ. Fl'ext., ext. cathar. veg. pil.
**Menispermum.*—Yellow Parilla. 24. Menispermaceæ. Fl'ext.
**Aletris.*—Colic Root. 542. Hæmodoraceæ.
Chamælirium.—Starwort. 552. Liliaceæ.
Collinsonia.—Stone-root. 444. Labiatæ.
**Gillenia.*—American Ipecac. 189. Rosaceæ.
**Triosteum.*—Bastard Ipecac. 264. Caprifoliaceæ.
**Xanthorrhiza.*—Yellow-root. 7. Ranunculaceæ.

CLASS V.—SWEETISH.

ASPIDIUM.—Male Fern. 584. Filices. Oleoresin
SPIGELIA.—Pinkroot. 370. Loganiaceæ. Fl'ext
TRITICUM.—Couch Grass. 584. Gramineæ. Fl'ext.

CLASS VI.—ASTRINGENT.

(*a*) **With Rootlets.**

**Geum Rivale.*—Water Avens. 188. Rosaceæ
Geum Urbanum.—Avens. 188. Rosaceæ.

(*b*) **With Few or no Rootlets.**

GERANIUM.—Cranesbill. 77. Geraniaceæ. Fl'ext.
Bistorta.—Bistort. 453. Polygonaceæ.
Nymphæa.—Water Lily. 32. Nymphæaceæ.
**Tormentilla.*—Tormentil. 186. Rosaceæ.

UNCLASSIFIED.—All unofficial: Actæa, 3. Adruc, 574. Aralia Hispida, 258. Asparagus, 554. Carex, 573. Cnicus Arvensis, 288. Corallorrhiza, 532. Jeffersonia, 28. Rubia, 266. Sarracenia, 33.

TUBERS, BULBS, AND CORMS.

(*Mostly Acrid.*)

TUBERS.

ACONITUM.—Aconite. 14. Ranunculaceæ. Fl'ext., tr., ext.
JALAPA.—Jalap. 383. Convolvulaceæ. Ext., resin, co. powd., co. cathar. pil., co. veg. cath. pil.
Corydalis.—Turkey Corn. 41. Fumariaceæ.
Salep.—Salep. 533. Orchidaceæ.

BULBS.

**Allium.*—Garlic. 555. Liliaceæ.
SCILLA.—Squill. 556. Liliaceæ. Fl'ext., tr., syr., co. syr., acetum.

CORMS.

COLCHICI CORMIS.—Colchicum-root. 557. Liliaceæ. Fl'ext., ext.
Arisæma Dracontium.—Green Dragon. 571. Araceæ.
**Arum.*—Indian Turnip. 570. Araceæ.

TWIGS AND BRANCHES.

**Dulcamara.*—Bittersweet. 396. Solanaceæ.
Gouania.—Chewstick. 118. Rhamnaceæ.
Pichi.—395. Solanaceæ.

WOODS.

**Guaiaci Lignum.*—Guaiac Wood. 75. Zygophyllaceæ.
HÆMATOXYLON.—Logwood. 141. Leguminosæ. Ext.
SANTALUM RUBRUM.—Red Saunders. 142. Leguminosæ. Tr. lavand. co.
QUASSIA.—96. Simarubaceæ. Fl'ext., ext., tr.
Juniperus Oxycedrus.—519. Pinaceæ. Oleum cadinum.
Ostrya.—Ironwood. 511. Cupuliferæ.
Sassafras Lignum.—Sassafras Wood. 471. Lauraceæ.
Santalum Album.—Sandalwood. 481. Santalaceæ. Oil.

BARKS.

CLASS I.—AROMATIC.

(*a*) **Deprived of Corky Layer.**
CINNAMOMUM ZEYLANICUM.—Ceylon Cinnamon. 467. Lauraceæ. Pulv. aromat.
**Cinnamomum Cassia.*—Cassia Cinnamon. 468. Lauraceæ.
SASSAFRAS.—470. Lauraceæ. Co. fl. ext. sars., co. syr. sars., oil in troch. cubeb.
**Canella.*—White Cinnamon. 48. Canellaceæ.
Cinnamodendron.—False Winter's Bark. 49. Canellaceæ.
Coto.—474. Lauraceæ.

(*b*) **With Periderm.**
**Cascarilla.*—490. Euphorbiaceæ.
CINNAMOMUM SAIGONICUM.—Saigon Cinnamon. 469. Lauraceæ, tr. card. co., tr. catechu co., tr. rhei arom., tr. lavand. co., vin opii inf. digitalis.
**Angustura.*—81. Rutaceæ.
**Wintera.*—Winter's Bark. 20. Magnoliaceæ.
Betula Lenta.—Sweet Birch. 501. Betulaceæ. Vol. oil.

CLASS II.—ACRID.

GOSSYPII RADICIS CORTEX.—Cotton-root Bark. 69 a. Malvaceæ. Fl'ext.
MEZEREUM.—Mezereum. 480. Thymelæaceæ. Fl'ext.
QUILLAJA.—Soap Bark. 175. Rosaceæ. Tr.
XANTHOXYLUM.—Prickly Ash. 81. Rutaceæ. Fl'ext.
Erythrophlœum.—Sassy Bark. 137. Leguminosæ.
Pisicidia.—Jamaica Dogwood. 140. Leguminosæ.

CLASS III.—BITTER.

**Aspidosperma.*—Quebracho. 353. Apocynaceæ.
EUONYMUS.—Wahoo. 112. Celastrineæ. Ext.
FRANGULA.—Buckthorn. 114. Rhamnaceæ. Fl'ext.
**Juglans.*—Butternut. 502. Juglandaceæ. Ext.
RHAMNUS PURSHIANA.—Cascara Sagrada. 115. Rhamnaceæ. Fl'ext., ext. aromatic.
**Azedarach.*—Margosa Bark. 108. Meliaceæ.
**Quassiæ Cortex.*—Quassia Bark. 97. Simarubaceæ.
**Simaruba.*—98. Simarubaceæ.

CLASS IV.—BITTER AND ASTRINGENT.

CINCHONA.—267 Rubiaceæ. Fl'ext., tr., co. tr., various alkaloidal salts.
CINCHONA RUBRA.—267. Rubiaceæ. Comp. tinct.
PRUNUS VIRGINIANA.—Wild Cherry. 166. Rosaceæ. Fl'ext., syr., inf.
VIBURNUM.—Opulus. 262. Caprifoliaceæ. Fl'ext.
VIBURNUM PRUNIFOLIUM.—Black Haw. 263. Caprifoliaceæ. Fl'-ext.
Pinus Strobus.—White Pine. 518. Pinaceæ.
**Cornus Florida.*—Dogwood. 259. Cornaceæ.
**Berberis.*—Barberry Bark. 30. Berberidaceæ.
**Liriodendron.*—Tulip-tree Bark. 21. Magnoliaceæ.
**Magnolia.*—19. Magnoliaceæ.
**Nectandra.*—Beeberu. 473. Lauraceæ.
**Prinos.*—Black Alder. 111. Ilicineæ.
Chaparro Amargoso.—Amargosa. Simarubaceæ. 101½.

CLASS V.—ASTRINGENT.

GRANATUM.—Bark of Pomegranate Root. 211. Punicaceæ. Pelletierine Tannate.
QUERCUS ALBA.—White Oak. 505. Cupuliferæ. Fl'ext.
RUBUS.—Blackberry. 180. Rosaceæ. Fl'ext., syr.
HAMAMELIDIS CORTEX.—Witchhazel Bark. 200. Hamamelidaceæ water.
**Salix.*—Willow. 512. Saliaceæ.

CLASS VI.—MUCILAGINOUS.

ULMUS.—Slippery Elm. 495. Ulmaceæ. Mucilage.

UNCLASSIFIED.—All unofficial: Acer Rubrum, 124. Æsculus Glabra, 122. Ailanthus, 100. Alnus, 506. Alstonia Constricta, 354. Alstonia Scholaris, 355. Ampelopsis, 120. Calycanthus, 17. Carya, 502 b. Cascara Amarga, 106. Celastrus, 113. Cephalanthus, 269. Cercis, 138. Chionanthus, 350. Choke Cherry, 167. Cocillana, 108. Condurango, 365. Conessi, 356. Fagus, 507. Fraxinus Americana, 348. Fraxinus Sambucifolia, 349. Hippocastanum, 123. Hoang-Nan, 368. Juglans Nigra, 502 a Larix, 521. Lindera, 475. Malus, 170. Mistletoe, 482. Myrica, 503. Newbouldia, 409. Populus, 513. Ptelia, 82. Rhus Aromatica, 128. Saraca, 139. Tonga, 414. Tsuga, 520.

LEAVES.

CLASS I —AROMATIC.

BUCHU (Short).—83. Rutaceæ. Fl'ext.
**Buchu* (Long).—83. Rutaceæ. Fl'ext.
COCA.—74. Erythroxylaceæ. Fl'ext., cocaine hydrochloride.

ERIODICTYON.—Yerba Santa. 377. Hydrophyllaceæ. Fl'ext.
EUCALYPTUS.—204. Myrtaceæ. Fl'ext., vol. oil, eucalyptol.
MATICO.—460. Piperaceæ. Fl'ext., tr.
PILOCARPUS.—Jaborandi. 84. Rutaceæ. Fl'ext.
Rosmarinus.—Rosemary. 435. Labiatæ. Vol. oil, tr. lavand. co., linimentum saponis.
SALVIA.—Sage. 484. Labiatæ.
**Tabacum.*—Tobacco. 393. Solanaceæ.
Chekan.—Cheken. 206. Myrtaceæ.
Myrcia.—Bay Leaves. 205 a. Myrtaceæ. Vol. oil
Melaleuca.—Cajuput. 210. Myrtaceæ. Oleum cajuputi.
**Conii Folia.*—Hemlock Leaves. 231. Umbelliferæ.
Thymus.—Garden Thyme. Labiatæ. Oil, thymol.

CLASS II.—ACRID.

**Ruta.*—Rue. 85. Rutaceæ.

CLASS III.—BITTER.

BELLADONNÆ FOLIA.—Deadly Nightshade. 387. Solanaceæ. Tr., ext., oint., plast., extract in pil. laxative comp., pil. pod. bell. et capsic.
DIGITALIS.—Foxglove. 400. Scrophulariaceæ. Fl'ext., tr., ext., inf.
HYOSCYAMUS.—Henbane. 391. Solanaceæ. Fl'ext., tr., ext.
SENNA (Alexandria).—144. Leguminosæ. } Fl'ext., syr., co. inf., conf., pulv. glycyr. co., syr. sars. co.
Senna (India).—144. Leguminosæ. }
STRAMONII FOLIA.—Stramonium Leaves. Solanaceæ. Fl'ext.
Duboisia.—394. Solanaceæ.
**Hepatica.*—Liverwort. 15. Ranunculaceæ.

CLASS IV.—ASTRINGENT.

**Castanea.*—Chestnut. 509. Cupuliferæ.
CHIMAPHILA.—Pipsissewa. 331. Ericaceæ. Fl'ext.
HAMAMELIDIS FOLIA.—Witchhazel. 197. Hamamelideæ. Fl'ext.
**Rhus Toxicodendron.*—Poison Ivy. 127. Anacardiaceæ.
UVA URSI.—Bearberry. 328. Ericaceæ. Fl'ext.
**Gaultheria.*—Wintergreen. 330. Ericaceæ. Vol. oil.

UNCLASSIFIED.—All unofficial: Ambrosia, 293. Arctostaphylos, 329. Aurantii Folia, 89. Betonica, 442. Boldus, 464. Borago, 376. Caroba, 410. Cassia Marilandica, 144. Comptonia, 504. Duboisia, 394. Epigæa, 332. Erechthites, 289. Erythronium, 561. Eupatorium Purpureum, 297. Euphrasia, 399. Fragaria, 184. Garrya, 260. Guaco, 292. Kalmia, 334. Ilex Opaca, 110. Ilex Paraguayensis, 111. Laurocerasus, 183. Laurus, 476. Ledum, 335. Ligustrum, 351. Lippia Mexicana, 411. Mitella Nuda, 197. Monarda Fistulosa, 429. Ocimum, 441. Oleander, 358. Orthosiphon, 437. Oxydendrum, 336. Persica, 169. Polypodium, 587. Pterocaulon, 291. Pulmonaria, 310. Pycnanthemum, 438. Rhododendron, 337. Satureia, 439. Sesamum, 408 a. Spinosum, 295. Strumarium, 294. Thea, 62. Trilisa, 290. Turnera, 215. Umbellularia, 477. Vaccinium, 333. Verbascum, 402. Yerba Buena, 440.

LEAFY TOPS.

All Balsamic, Camphoraceous and Bitter.
SABINA.—Savine. 516. Coniferæ. Fl'ext., vol. oil.
**Juniperus Virginiana.*—Red Cedar. 516 a. Coniferæ.
Thuja.—Arbor Vitæ. 517. Coniferæ.

HERBS AND WHOLE PLANTS.

CLASS I.—AROMATIC.

Labiatæ.

HEDEOMA.—Pennyroyal. 417. Vol. oil.
MARRUBIUM.—Horehound. 418.
MENTHA PIPERITA.—Peppermint. 415. Vol. oil, spts., water, troch., menthol. pil. rhei co., mist. rhei et sod.
MENTHA VIRIDIS.—Spearmint. 416. Vol. oil., spts., water.
**Melissa.*—Balm. 419.
**Cataria.*—Catnip. 431.
Glechoma.—Ground Ivy. 423.
Hyssopus.—Hyssop. 430.
**Lycopus.*—Bugle Weed. 424.
Majorana.—Sweet Marjoram. 425.
Monarda.—Horsemint. 428.
**Origanum.*—Wild Marjoram. 421.

Compositæ.

GRINDELIA.—298. Fl'ext.
**Tanacetum.*—Tansy. 299.
**Achillea.*—Yarrow. 306.
**Cotula.*—May Weed. Wild Chamomile. 320.
Parthenium.—Feverfew. 319.
**Solidago.*—Golden Rod. 315.

Hypocreaceæ (Cryptogamous).

ERGOTA.—Ergot. 590. Fl'ext., ext., wine.
**Ustilago.*—Corn Smut. 593.

CLASS II.—BITTER.

Compositæ.

Absinthium.—Wormwood. 300.
EUPATORIUM.—Boneset. 296. Fl'ext.
Carduus Benedictus.—Blessed Thistle. 308.
**Erigeron.*—Fleabane. 302. Oil.
**Erigeron Canadense.*—303.
Helenium.—Sneezewort. 305.

Gentianaceæ.

CHIRATA.—Chiretta. 374. Fl'ext.
**Sabbatia.*—Centaury. 375.

Leguminosæ.

SCOPARIUS.—Broom. 148. Fl'ext.
Melilotus.—Sweet Clover. 145.
Galega.—Goat's Rue. 147 a.

Scrophulariaceæ.

Chelone.—Balmony. 406.
Scrophularia.—Figwort. 405.

Polygalaceæ.

**Polygala.*—Bitter Polygala. 54.

Violarieæ.

Viola Tricolor.—Pansy. 47.

Ranunculaceæ.

Coptis.—Goldthread. 4.

Fungi.

Agaricus Albus.—White Agaric. 594.
Fungus Chirurgorum.—Surgeon's Agaric. 594 a.
Torula.—Yeast. 595.

CLASS III.—ACRID.

Ranunculaceæ.
Pulsatilla.—8.
Ranunculus.—Crowfoot. 10.

Cruciferæ.
Bursa Pastoris.—Shepherd's Purse. 44.

Campanulaceæ.
LOBELIA.—Indian Tobacco. 327. Fl'ext., tr.

Moraceæ.
CANNABIS INDICA.—Indian Hemp. 498. Fl'ext., tr. ext.

Papaveraceæ.
Chelidonium.—Celandine. 37.

Cacteæ.
Cactus.—Night-blooming Cereus. 226.

Droseraceæ.
Drosera.—Sundew. 198.

Hypericineæ.
Hypericum.—St. John's-wort. 60.

CLASS IV.—ASTRINGENT.

Rosaceæ.
Agrimonia.—Agrimony. 190.
Potentilla.—Cinquefoil. 191.

Rubiaceæ.
Galium.—Cleavers. 271.
Mitchella.—Squaw Vine. 270.

Onagrarieæ.
Œnothera.—Evening Primrose. 214.
Epilobium.—Willow Herb. 213.

Cistineæ.
Helianthemum.—Frostwort. 46.

Plantagineæ.
Plantago.—Plantain. 445.

Orobanchaceæ.
Epiphegus.—Beech-drop. 407.

CLASS V.—MUCILAGINOUS.

All Cryptogamous.
Cetraria.—Iceland Moss. 590. Lichenes. Decoction.
CHONDRUS.—Irish Moss. 596 Algæ. (Gigartinaceæ, U. S. P., 1900.)
Adiantum.—Maidenhair Fern. 584. Filices.
Fucus Nodosus. 597 a. Algæ.
Fucus Vesiculosus.—Bladderwrack. 597 Algæ.
Laminaria.—Sea-girdles. 598. Algæ.

UNCLASSIFIED.—All unofficial: Adonis Vernalis, 9. Anagallis, 340. Anhalonium, 227. Artemisia, 301. A. Abrotanum, 301 a; A. Vulgaris, 301 b; A. Frigida, 301 c. Asclepias Curassavica, 363. Bidens, 313. Elephantopus, 321. Ephedra, 515. Equisetum, 582. Eschscholtzia, 38. Euphorbia Pilulifera, 484 c. Frankenia, 55. Gnaphalium, 304. Impatiens, 78. Lactuca Sativa, 317. Lactuca Canadensis, 318. Lamium, 415. Leonurus, 427. Litmus, 591. Menyanthes, 376. Mercurialis, 487. Mutisia, 310. Passiflora, 217. Penthorum, 196. Polygonum, 452. Portulaca, 59. Rudbeckia, 312. Sedum Acre, 197. Senecio, 314. Silphium, 309. Solanum Carolinense, 397. Spiræa, 192. Stellaria, 58. Stylosanthes, 147. Teucrium, 432. Trifolium Pratense, 146. Trifolium Repens, 146 a. Urechites, 359. Urtica, 499. Veronica Officinalis, 404. Commelina, 572.

FLOWERS, BULBS, AND PETALS.

CLASS I.—AROMATIC.

ANTHEMIS.—Chamomile. 322. Compositæ.
CALENDULA.—Marigold. 324. Compositæ. Tr.
CARYOPHYLLUS.—Cloves. 207. Myrtaceæ. Vol. oil, tr. lavand. co., tr. rhei arom., vin. opii.
MATRICARIA.—German Chamomile. 321. Compositæ.
ROSA GALLICA.—Red Rose. 176. Rosaceæ. Fl'ext., syr., honey, conf., pil. aloe et mastiche, oil.
**Rosa Centifolia.*—Pale Rose. 177. Rosaceæ.
**Sambucus.*—Elder. Caprifoliaceæ
SANTONICA.—Levant Wormseed. 323. Compositæ. Santonin, troch. santonin.
**Aurantii Flores.*—Orange Flowers. 90. Aurantiaceæ. Vol. oil.
**Lavandula.*—Lavender. 443. Labiatæ.
Populus Balsamifera.—Balm of Gilead Buds. 514. Salicaceæ.

CLASS II.—ACRID.

ARNICA.—287. Compositæ. Tincture.

CLASS III.—BITTER.

CUSSO.—Kousso. 185. Rosaceæ.
**Carthamus.*—Safflower. 325. Compositæ.
Rhœas.—Red Poppy. 40. Papaveraceæ.
Ambrosia Artemisiæfolia.—Ragweed. Compositæ. 293 a.

CLASS IV.—DEMULCENT.

Althæa Rosea.—Hollyhock. 67. Malvaceæ.
Malva.—Mallow. 68 Malvaceæ
Tilia.—Linden Flowers. 72. Tiliaceæ.

FRUITS.

CLASS I.—AROMATIC.

(*a*) **Cremocarps.**—Umbelliferous fruits, consisting of two carpels or mericarps joined by their flat sides but easily separable.
ANISUM.—Anise. 218. Umbelliferæ. Spirits, water, vol. oil, syr. sars. co., tr. opii camph., troch. glycyrr. et opii, spt. auranti co.
CARUM.—Caraway. 232. Umbelliferæ. Tr. card. co., spt. junip. co., vol. oil.
CORIANDRUM.—Coriander. 233. Umbelliferæ Vol. oil, conf. sennæ, spt. aurant. co., syr. sennæ.
FŒNICULUM.—Fennel. 229. Umbelliferæ. Vol. oil, water, inf. sennæ co., pulv. glycyrr. co., spt. junip. co.
Anethum.—Dill. 234. Umbelliferæ.
Apium.—Celery Fruit. 235. Umbelliferæ.
Cuminum.—Cumin Fruit. 240. Umbelliferæ.

b) **Globular.**
**Chenopodium.*—American Wormseed. 446. Chenopodiaceæ. Vol. oil.
CUBEBA.—Cubebs. 436. Piperaceæ. Fl'ext., vol. oil, oleores., troches.
PIMENTA.—Allspice. 208. Myrtaceæ. Vol. oil, spt. myrciæ.
SABAL.—Saw Palmetto. Palmæ. 563.
PIPER.—Black Pepper. 457. Piperaceæ. Oleoresin, piperin
**Juniperus.*—Juniper. 518. Pinaceæ. Oil.
Piper Album.—White Pepper. 458. Piperaceæ.
Piper Longum.—Long Pepper. 459. Piperaceæ.

(*c*) **Of Various Forms.**

AURANTII AMARI CORTEX.—Orange Peel. 87. Rutaceæ. Fl'ext., tr., tr. cinch. co., tr. gentian. co., vol. oil.

AURANTII DULCIS CORTEX.—Tr., syr., spt. aurant. co.

CAPSICUM.—Cayenne Pepper. 398. Solanaceæ. Fl'ext., tr., oleoresin, plaster.

CARDAMOMUM.—Cardamom. 539. Zingiberaceæ. Tr., co. tr., arom. powd., tr. gent. co., ext. colocynth. co., tr. rhei.

HUMULUS.—Hops. 496. Moraceæ.

**Illicium.*—Star Anise. 18. Magnoliaceæ.

LIMONIS CORTEX.—Lemon Peel. 92. Aurantiac. Spts. auranti co., spt. ammon. aromat.

VANILLA.—534. Orchidaceæ. Tr.

Caryophylli Fructus.—Mother Clove. 207 a. Myrtaceæ.

Citrus Bergamia.—Bergamotte. 94. Aurantiaceæ. Vol. oil.

Dipteryx.—Tonka Bean. 153. Leguminosæ.

CLASS II.—ODORLESS AND TASTELESS.

CONIUM.—Hemlock Fruit. 230. Umbelliferæ. Fl'ext.

CLASS III.—BITTER.

COLOCYNTHIS.—Colocynth. 219. Cucurbitaceæ. Ext., co. ext., pil. cathar. co., pil. veg. cathar.

Cocculus.—Cocculus Indicus. Fishberry. 25. Menispermaceæ. Picrotoxin.

Lappæ Fructus.—Burdock Fruit. 281. Compositæ.

**Papaver.*—Poppy. 35. Papaveraceæ.

CLASS IV.—SWEET.

CASSIA FISTULA.—Purging Cassia. 149. Leguminosæ. Confec. sennæ.

FICUS.—Fig. 500. Moraceæ. Confec. sennæ.

**Phytolaccæ Fructus.*—Poke Berries. 448. Phytolaccaceæ.

PRUNUM.—Prune. 168. Rosaceæ. Confec. sennæ.

TAMARINDUS.—Tamarind. 151. Leguminosæ. Confec. sennæ.

CLASS V.—ACIDULOUS.

RHUS GLABRA.—Sumach. 127. Anacardiaceæ. Fl'ext.

**Rubus Idæus.*—Raspberry. 181. Rosaceæ.

Rosa Canina.—Hips. 178. Rosaceæ.

CLASS VI.—ASTRINGENT.

Bela.—Bael Fruit. 86. Rutaceæ.

**Granati Fructus Cortex.*—Pomegranate Rind. 212. Punicaceæ.

UNCLASSIFIED.—All unofficial: Ajowan, 246. Anacardium, 131. Ananassa, 541. Carota, 241. Ceratonia, 150. Diospyros, 343. Embelia, 341. Luffa, 220 Lycopersicum, 399. Mangostana, 62. Momordica, 221. Morus, 501. Myrobalanus, 203. Phellandrium, 239. Rhamnus Cathartica, 116. Semecarpus, 133. Serenoa 563. Uva Passa, 119. Xanthoxyli Fructus, 82. Cratægus, 182.

SEEDS.

CLASS I.—AROMATIC.

MYRISTICA.—Nutmeg. 565. Myristicaceæ. Pulv. aromat., tr. lavand. co., tr. rhei arom., troch. sod. bicarb., vin. opii, vol. oil.

**Caffea.*—Coffee. 272. Rubiaceæ. Caffeine, caffeine citrate, caff. cit. efferves.

Cola.—Cola. 70. Sterculiaceæ.
Fœnum Græcum.—Fenugreek. 153. Leguminosæ.
Granum Paradisi.—Grain of Paradise. 540. Zingiberaceæ.
Areca.—Areca Nut. 562. Palmaceæ.

CLASS II.—BITTER.

AMYGDALA AMARA.—Bitter Almond. 172. Rosaceæ. Syr., vol. oil, water, spts., fixed oil.
NUX VOMICA.—Dog Button. Loganiaceæ. Fl'ext., ext., tr.
STAPHISAGRIA.—Stavesacre. 11. Ranunculaceæ.
STROPHANTHUS.—357. Apocynaceæ. Tr.
**Delphinium.*—Larkspur. 12. Ranunculaceæ.
**Ignatia.*—St. Ignatius' Bean. 367. Loganiaceæ.

CLASS III.—ACRID.

COLCHICI SEMEN.—Colchicum Seed. 558. Liliaceæ. Fl'ext., tr., wine.
SINAPIS ALBA.—White Mustard. 42. Cruciferæ.
SINAPIS NIGRA.—Black Mustard. 43. Cruciferæ. Charta, vol. oil.
Curcas.—Purging Nut. 493. Euphorbiaceæ.
**Hyoscyami Semen.*—Henbane Seed. 392. Solanaceæ.
Nigella.—13. Ranunculaceæ.
Ricinus.—Castor Bean. 491. Euphorbiaceæ. Oil.
**Sabadilla.*—Cevadilla. 550. Liliaceæ. Veratrine, unguent. veratrin., oleat. veratrin.
Tiglium.—Croton Seed. 492. Euphorbiaceæ. Oil.

CLASS IV.—MUCILAGINOUS OR OILY.

AMYGDALA DULCIS.—Sweet Almond. 173. Rosaceæ. Syr., emul., express. Oil in unguent., aqua rosæ.
LINUM.—Flax Seed. 73. Linaceæ.
PEPO.—Pumpkin Seed. 222. Cucurbitaceæ.
PHYSOSTIGMA.—Calabar Bean. 155. Leguminosæ. Tr., ext., physostigmine (eserine) and salts.
**Stramonii Semen.*—Stramonium Seed. 390. Solanaceæ.
**Cydonium.*—Quince Seed. 171. Rosaceæ.
Theobroma.—Cacao. 71. Sterculiaceæ.
**Papaver.*—Poppy, or Maw Seed. 36. Papaveraceæ.

UNCLASSIFIED.—All unofficial: Abri Semen, 136. Cannabis Semen, 498 a. Cedron, 99. Gynocardia, 50. Helianthus, 326. Jambul, 209. Persea, 479. Cucumis, 224. Sesamum, 408 b. White Zapote, 95.

CELLULAR DRUGS AND PRODUCTS FROM FRAGMENTS OF THE PLANT.

CLASS I.—AROMATIC.

**Crocus.*—Saffron. 545. Iridaceæ. Tr.
LIMONIS SUCCUS.—Lemon Juice. 91. Aurantiaceæ. Citric acid, syrup.
LUPULINUM.—Lupulin. Glands from hops. 497. Moraceæ. Fl'ext., oleores.
**Macis.*—Mace. Arillode of Nutmeg. 466 Myristicaceæ.

CLASS II.—ODORLESS AND TASTELESS.

LYCOPODIUM.—582. Lycopodiaceæ.
GOSSYPIUM PURIFICATUM.—Cotton. 69 b. Malvaceæ. Pyroxylin, collodion, collod. styp., collod. flexib., collod. cantharid.
**Kamala.*—Rottlera. 494. Euphorbiaceæ.
Cibotium.—Penghawar. 586. Filices.

CLASS III.—BITTER.

Araroba.—Goa Powder. 156. Leguminosæ. Chrysarobin, unguent. chrysaro.

CLASS IV.—ASTRINGENT.

GALLA.—Nutgalls. 508. Cupuliferæ. Tr. unguent., Tannic acid, which enters into troch., glycerite, collod. styp.
**Mucuna.*—Cowage. 155. Leguminoseæ.

CLASS V.—MUCILAGINOUS.

SASSAFRAS MEDULLA.—Sassafras Pith. 472. Lauraceæ. Mucilage.

CLASS VI.—SWEETISH.

ZEA.—Corn Silk. 578. Gramineæ. Fl'ext.

CLASS VII.—FARINACEOUS.

AMYLUM.—Starch. 580. Gramineæ. Glycerit.
**Avenæ Farina.*—Oat Meal. Gramineæ.
**Hordeum.*—Pearl Barley. 581 a. Gramineæ.
**Sago.*—Pearl Sago. Gramineæ.
**Tapioca.*—Euphorbiaceæ.
Taro, Triticum vulgare, Oryza, Solanum tuberosum, Canna, Maranta, and Curcuma leucorrhiza.

NON-CELLULAR DRUGS DERIVED FROM CELL-PRODUCTS, INCLUDING SECRETIONS.

FARINACEOUS.

AMYLUM.—Starch (see above).

EXTRACTIVE SUBSTANCES.

Extracts.

CATECHU (Gambir).—Cutch. 159. Leguminosæ. Co. tr., troch.
EXTRACTUM GLYCYRRHIZÆ.—Licorice. 133 a. Leguminosæ. Troch. g. et opii, troch. ammon. chlor., pil. ferri iod., troch. cubeb.
GUARANA.—121. Sapindaceæ. Fl'ext.
Annatto.—Arnotta. 51. Bixineæ.
**Catechu Pallidum.*—Gambir. 273. Rubiaceæ.
Curara.—Curare. 371. Loganiaceæ.
Monesia.—343. Sapotaceæ.

Concrete Juices.

ALOE.—Aloes. 559. Liliaceæ. Tr., aloe purificata, tr. a. et myrrh, tr. benzoin. co., ext. colocyn. co., pil., pil. al. et mastich., pil. a. et myrrh., pil. rhei co., pil. cathar. co., pil. veg. cathar., aloin. (the latter in pil. aloin co.).
KINO.—160. Leguminosæ. Tr.
LACTUCARIUM.—Lettuce Opium. 316. Compositæ. Tr., syr.
OPIUM.—34. Papaveraceæ. Pulv., deod. opium, tr., ext., wine, pil., pul. ipecac. et o., deod. tr., tr. ipecac. et o., tr. opii camph., troch. glycyrr. et o., morphine and its salts, morph. hydrochlor., mor. sulph., codeine, apomorph. hydrochlor.
ELASTICA.—India Rubber. 488 Euphorbiaceæ. Chart. sinapis.
Alveloz Milk.—486.
**Gutta Percha.*—342. Sapotaceæ.
Papaya.—Papain. 216. Passifloraceæ.

SACCHARINE SUBSTANCES.

Solid.

MANNA.—346. Oleaceæ. Inf. sennæ co.
SACCHARUM.—Sugar. Cane Sugar. Gramineæ. Syrups, pills, powders, etc.
SACCHARUM LACTIS.—Sugar of Milk. 617 d.

Liquid.

MEL.—Honey. 612. Mel despumat., mel rosæ, conf. rosæ.

MUCILAGINOUS SUBSTANCES.

Gums.

ACACIA.—Gum Arabic. 157. Leguminosæ. Mucilage, syr , pul. cret. co., mist. glycyr. co., emul. amyg., pil. fe. iod., pil. phos., troch. glycyr. et opii.
TRAGACANTHA.—Gum Tragacanth. 158. Leguminosæ. Mucilage, troch. ammon. chlor., troch. catechu, troch., tannic acid, and others.

RESINOUS SUBSTANCES.

Gum Resins.

Aromatic.—Containing volatile oil.
ASAFŒTIDA.—244. Umbelliferæ. Tr., pil., emul.
**Ammoniacum.*—Ammoniac. 246. Umbelliferæ.
MYRRHA.—Myrrh. 102. Burseraceæ. Tr., tr. aloes et m., pil. aloes et m., pil. rhei co., mis. ferri co.
Bdellium.—104. Burseraceæ.
**Galbanum.*—245. Umbelliferæ.
Olibanum.—Frankincense. 103. Burseraceæ.

Acrid.—Free from volatile oil.
CAMBOGIA.—Gamboge. 61. Guttifereræ. Pil. cathar. co.
SCAMMONIUM.—Scammony. 385. Convolvulaceæ. Resin, ext. colocynth. co
Euphorbium.—485. Euphorbiaceæ.

Pure Resins.—(*Benzoin sometimes classified as Solid Balsam.*)

Aromatic.
BENZOINUM.—345. Styraceæ. Tr., co. tr., benzoinated lard, tr. opii camph.
RESINA.—Rosin. 522 c. Pinaceæ. Plas., cerate, co. cerate.
Xanthorrhœa.—Acaroid Resin. 560. Liliaceæ.

Odorless and Tasteless.
Copal.—163 Leguminosæ.
Dammara.—Dammar. 528. Coniferæ.
Draconis Resina.—Dragon's Blood. 565. Palmæ.
Kauri Resin.—Kauri Gum. 529. Coniferæ.
**Succinum.*—Amber. 527. Coniferæ.

Bitter.
MASTICHE.—Mastic. 229. Anacardaceæ. Pil. aloes et m.
Elaterium.—225. Cucurbitaceæ. Elaterinum, tritur elater.
Lacca.—Lac. 489. Euphorbiaceæ.
Sandaracca.—530. Coniferæ.

Acrid.
GUAIACUM.—Guaiac Resin. 76 Zygophylaceæ. Tr., ammoniated tr.

Oleoresins.

COPAIBA.—Copaiva 161 Leguminosæ. Mass, vol. oil, resin, solidified.
Pix Burgundica.—Burgundy Pitch. 526. Coniferæ. Plas., canthar. plas., iron plas , opium plas.
PIX LIQUIDA.—Tar. 523. Pinaceæ. Syr., oint., vol oil.

TEREBINTHINA.—522. Pinaceæ. Vol. oil in emuls , rectified oil, liniment, terbene, terpin hydrate, canthar. cer., resin, resin. cer., res. plas.
TEREBINTHINA CANADENSIS.—524. Pinaceæ.
Elemi.—105. Burseraceæ.
Gurjun.—Gurjun Balsam. 64 Dipterocarpeæ.
**Pix Canadensis.*—Canada Pitch. 525. Coniferæ.
Terebinthina Chia.—Chian Turpentine. 139. Anacardiaceæ.
Venice Turpentine.—522 a. Coniferæ.

Balsams.
BALSAMUM PERUVIANUM.—Balsam of Peru. 164. Leguminosæ.
BALSAMUM TOLUTANUM.—Balsam of Tolu. 165. Leguminosæ Tr., syr., tr. benzoin. co., pil. ferri iod., pil. phos., syrupus tolu in troch. ammon. chlor.
STYRAX.—Storax. 201. Hamamelidaceæ. Tr. benzoin. co.
Liquidambar.—Sweet Gum. 202 Hamamelidaceæ.

STEAROPTENS OR CAMPHOR.

CAMPHORA.—Camphor. 478. Lauraceæ. Spt., water, liniment, cerat., tr. opii camph., linim. belladon., linim. sapon., linim. chlorofor. Derivatives: Monobromated camphor, camphoric acid.
MENTHOL.—Pipmenthol. 415 b. Labiatæ.
THYMOL.—Thymol. 237. Umbelliferæ and Labiatæ.
Borneo Camphor.—65. Dipterocarpeæ.

FATTY SUBSTANCES.

LIQUID.

Of Vegetable Origin.

From Seeds.
OLEUM AMYGDALÆ EXPRESSUM.—Expressed Oil of Almond. 174. Rosaceæ. Ung. aqu. ros.
OLEUM GOSSYPII SEMINIS.—Cotton-seed Oil. 69 c. Malvaceæ. Lini. ammoniæ, lini. camphoræ.
OLEUM LINI.—Linseed Oil. 73 a. Lineæ. Lini. calcis, sapo molis, linim. sapo molis.
OLEUM RICINI.—Castor Oil. 491 a. Euphorbiaceæ. Collod. flexile.
OLEUM TIGLII.—Croton Oil. 492 a. Euphorbiaceæ.
Oleum Juglandis.—Nut Oil. 502. Juglandaceæ.
Macassar Oil.—125. Sapindaceæ.,
Pongamia Oil.—162. Leguminosæ.
Oleum Papaveris Poppyseed Oil. 36 a. Papaveraceæ.
Oleum Sesami.—Benne-seed Oil. 408 c. Pedalinæ.
Oleum Sinapis Expressum.—Expressed Oil of Mustard. 43 b. Cruciferæ.

From Fruits.
OLEUM OLIVÆ.—Sweet Oil. 347 Oleaceæ. Sapo. Lead plaster, oint. veratrine, in unguent. diachylon.
Oleum Cannabis.—Oil of Hempseed. 498 b. Moraceæ.
Oleum Maydis.—Maize Oil. 579. Gramineæ.

Of Animal Origin.
OLEUM ADIPIS.—Lard Oil. 622 a. Many cerates and ointments.
OLEUM MORRHUÆ.—Cod-liver Oil. 610. Emuls., emuls. ol. morrh. cum hypophos.
Oleum Bubulum.—Neats-foot Oil. 621

SOLID.

Of Vegetable Origin.

From Seeds.

OLEUM THEOBROMATIS.—Cacao Butter. 71. Sterculiaceæ.
Oleum Cocois.—Cocoanut Oil. 567. Palmæ.
Oleum Gynocardiæ.—Chaulmoogra Oil. 50 a. Bixineæ.

From Fruits.

Oleum Lauri.—Oil of Bays. Laurel Oil. 476 a Lauraceæ.
Oleum Palmæ—Palm Oil. 566. Palmæ.

Of Animal Origin.

ADEPS.—Lard. 622. Benzoinated lard in various ointments and cerates, cerate cantharides.
ADEPS LANÆ HYDROSUS.—Lanolin. Wool-fat. 625. Ung. hydrarg. ox. rub., ung. hydrarg. nit., etc.
SEVUM.—Suet. 620. Unguent. hydrarg., oleic acid, oleat. hydrarg., oleat. verat., oleat. zinc., stearic acid.
Butyrum.—Butter. 617 a.

Waxes.

CETACEUM.—Spermaceti. 611. Unguent. aquæ rosæ.
CERA ALBA.—White Wax. 612 a.
CERA FLAVA.—Yellow Wax. 612 b. Cera alba, cerate, cer. camphor., cer. resin., cer. canthar., tar oint.

Hydrocarbon Oils and Fats (used in various ointments and cerates).

Petrolatum Album.—White Petrolatum. 625 a.
Petrolatum Liquidum.—Liquid (oil). 625 a.
Petrolatum Molle.—Soft Petrolatum. 625 a. } **Petrolatum,** U. S.
Petrolatum Spissum.—Hard Petrolatum. 625 a. }

DRUGS OF ANIMAL ORIGIN.

I.—ANIMALS.

Insecta.

CANTHARIS.—Spanish Flies. 507 Collod., tr.
COCCUS.—Cochineal. 600. Tr. card. co.
Blatta.—Cockroach. 611.

Vermes.

Hirudo.—Blood-sucking Leech. 612.

II.—ANIMAL TISSUES AND SECRETIONS.

Poriphera.

Spongia.—Sponge. 613.

Polypiphera.

Corallium.—Coral. 604.

Acephala.

Testa.—Oyster Shell 605.

Cephalopoda.

Os Sepiæ.—Cuttle Fish Bone. 606.

Crustacea.

Calculi Cancrorum.—Crabs' Stones. 607.

Pisces.

**Ichthyocolla.*—Isinglass. 608.
OLEUM MORRHUÆ.—Cod-liver Oil. (See Fatty Substances.) 610.

Insecta.

CERA ALBA.—White Wax. (See Fatty Substances) 612 a.

CERA FLAVA.—Yellow Wax. (See Fatty Substances.) 612 b.
MEL.—Honey. (See Saccharine Substances.) 612.

Aves.

**Vitellus.*—Egg-yolk. 613. Glycerite.
Ovum —Egg. 13.
Albumen Ovi.—White of Egg.
Testa Ovi.—Egg-shell.

Mammalia.

ADEPS.—Lard. (See Fatty Substances) 622.
ADEPS LANÆ HYDROSUS.—Lanolin. (See Fatty Substances) 625.
CETACEUM.—Spermaceti. (See Fatty Substances.) 611.
FEL BOVIS.—Ox-gall. 615.
FEL BOVIS PURIFICATUM.—Purified Ox-gall. 615 a.
MOSCHUS.—Musk. 614. Tr.
OLEUM ADIPIS.—Lard Oil. (See Fatty Substances.) 622 a.
PANCREATINUM.—Pancreatin. 624.
PEPSINUM.—Pepsin. 623. Saccharated p.
SEVUM.—Suet. (See Fatty Substances.)
Castoreum.—Castor. 627.
Civetta.—Civet. 628.
Gelatinum.—Gelatin. 619.
Hyraceum.—Hyraceum. 626.
Lac.—Milk 617.
(*a*) Butyrum.—Butter. (See Fatty Substances.)
(*b*) **ACIDUM LACTICUM.**—Lactic Acid.
(*c*) **SACCHARUM LACTIS.**—Sugar of Milk. (See Saccharine Substances.) Used chiefly as diluent.
Os.—Bone. 618.
Oleum Bubulum.—Neats-foot Oil. (See Fatty Substances.) 621.
Sanguis.—Blood. 616.

Bacterial Products.

Antitoxic Serums. 629.
Serum Antidiptheriticum. 629 a.

Glandular Products.

Glandulæ Suprarenales Siccæ. 629.
Glandulæ Thyreoideæ Siccæ. 630.

PURITY OF DRUGS AND DRUG ASSAY.

It is almost needless to say that the quality of drugs is of prime importance. A practical druggist will guard himself against inferior supplies; he will not take it for granted that they come to him absolutely pure, but will satisfy himself as to their value by careful inspection. In order to be a good inspector it is necessary to become acquainted with the characteristics of the normal drug; these characteristics and properties are set forth in the body of this work under each drug of importance. Every student should become so familiar with the drug and its characteristics that he can without difficulty recognize the presence of foreign substances not belonging to the drug in question. He should be able to tell without the least effort whether the drug is the one intended—whether there has been any mistake in packing, labelling, etc. It is a very uncommon occurrence, it is true, that this happens, but some quite serious results have followed from this very cause—mistake in labelling of crude drugs. The retail druggist is held responsible, as he is supposed to be a careful inspector of his materials. For examination of Drug Powders, see page 653.

Estimation of Value.—It is extremely difficult to estimate the value of drug material without resorting to certain chemical and physical means which are beyond the ordinary person to employ. It is often practically impossible to distinguish a good quality from an inferior one by the ordinary methods of observation. Especially is this true of the product as in the condition of a powder, a solid extract, or a liquid.

As to the identification and extraction of drug powders we have referred to this in some detail in Chapter XI of Part IV, page 653. With few exceptions under each official drug mentioned in the body of the work, there is stated the characteristic microscopical elements of the drug powder.

Drug Assay.—The chemical means resorted to for determining the medicinal as well as commercial value of drugs is known as drug assay. The toxic and alkaloidal drugs are of such value that it has become necessary to "standardize" them, as it is called. That is, the drug or preparation of it, to be recognized as official must reach by assay a certain standard of strength or activity in order to be classed as official. The Pharmacopœia gives the details of the process of assay for each of the drugs standardized.

A condensed statement regarding the principles of drug assay will be found in Section III (B), page 497.

The following is the list of **assayed drugs** and preparations of the United States Pharmacopœia:

	Percentage.		Fluidextract.*		Solid or Powd. Extract.
Aconite Root	0.5		0.4		
Bellad. Leaf	0.35		(Ext. 1.4	Plaster 0.38–0.42)	
" Root	0.5		0.5		
Scopola	0.5		0.5		2.0
Calabar Bean (Physostig.)	0.15				2.0
Cinchona (Physostig.)	4.0	(ether sol.)	4.0	(ether sol.)	
Coca	0.5		0.5		
Colchicum Corm	0.35				1.4
" Seed	0.55		0.5		
Conium	0.5		0.45		
Guarana	3.5		3.5		
Hydrastis	2.5		2.0		
Hyoscyamus	0.08		0.075		0.3
Ipecac	2.0		1.75		
Jalap (resin)	8.0	(not more than 1.5 % sol. in ether.)			
Nux Vomica (Strychnine)	1.25		1.0		5.0
Opium (Gum)	9.0				20.0
Opium (Powder and deodorized)	12.0 to 12.5				
Pilocarpus	0.5		0.4		
Stramonium	0.35		0.35		1.4

THE ASSAYED TINCTURES.

The assayed tinctures of the Pharmacopœia have the following amounts of alkaloids represented in one hundred cubic centimeters of tincture:

Tinctura Aconiti,	0.45 Gm. aconitine.
Tinctura Belladonnæ Foliorum,	0.035 Gm. belladonna alkaloids.
Tinctura Cinchonæ,	0.75 Gm. anhydrous ether-soluble alkaloids.
Tinctura Colchici Seminis,	0.05 Gm. colchicine.
Tinctura Hydrastis,	0.40 Gm. hydrastine.
Tinctura Hyoscyami,	0.007 Gm. mydriatic alkaloids.
Tinctura Nucis Vomicæ,	0.10 Gm. strychnine.
Tinctura Opii,	1.20 to 1.25 Gm. crystallized morphine.
Tinctura Opii Deodorati,	1.20 to 1.25 Gm. crystallized morphine.
Tinctura Physostigmatis,	0.014 Gm. ether-soluble alkaloids.
Tinctura Stramonii,	0.03 Gm. mydriatic alkaloids.

* Figures, representing alkaloidal strength of fluid extracts, show the amount in 100 Cc. of Fl'ext.

PART II.

DRUG DESCRIPTION.

SECTION I.—ORGANIC DRUGS FROM THE VEGETABLE KINGDOM, DESCRIBED AND ARRANGED ACCORDING TO FAMILIES OR NATURAL ORDERS.

PHANEROGAMS.

(Plants producing true seed.)

RANUNCULACEÆ.—Crowfoot Family.

Herbaceous or somewhat shrubby plants with acrid juice; distinguished by the parts of the flower—sepals, petals, stamens, and pistils—being *free and distinct*—that is, separated and independently situated on the receptacle. The *leaves* are dilated at base, one-half clasping the stem. *Fruit* a pointed or feathery akene, dry pod, or berry. The order has numerous anomalies in the form and structure of the calyx, and corolla in such genera as columbine, aconite, larkspur, ranunculus, anemone, etc., which, nevertheless, agree in the separation of their sepals and petals, the insertion of their numerous stamens, direction of their anthers, structure of seed, etc.

*Synopsis of Drugs from the Ranunculaceæ.**

A. *Rhizomes.*
- **CIMICIFUGA,** 1.
- **HYDRASTIS,** 2.
- Actæa, 3.
- Coptis, 4.
- Helleborus Niger, 5.
- Helleborus Viridis, 6.
- Xanthorrhiza, 7.

B. *Herbs.*
- Pulsatilla, 8.
- Adonis Vernalis, 9.
- Ranunculus, 10.

C. *Seeds.*
- **STAPHISAGRIA,** 11.
- Delphinium, 12.
- Nigella, 13.

D. *Tuber.*
- **ACONITUM,** 14.

E. *Leaf.*
- Hepatica, 15.

F. *Root.*
- Pæonia, 16.

1. CIMICIFUGA.—Cimicifuga.

BLACK SNAKEROOT. BLACK COHOSH. *Ger.* SCHWARZE SCHLANGENWURZEL. The dry rhizome and roots of **Cimicif′uga racemo′sa** Nuttall.

Botanical Characteristics.—*Stem* 4 to 8 feet high, from a thick rhizome; *leaves* alternate, ternately decompound; *flowers* regular, small, white, in wand-

* Official drugs are in bold-faced capitals.

like racemes often three feet long; *sepals* 5, petaloid; *petals* from 1 to 8, small, on claws, 2-horned at apex; *stamens* numerous; *pistils* 1 to 3; *fruit* 1 to several dry, dehiscent pods.

FIG. 1.—*Cimicifuga racemosa*—Plant and rhizome.

SOURCE.—This plant is common in rich woodlands of the United States, westward to Iowa and northward to Canada. *Actæ'a racemo'sa* is

mentioned by Flückiger as a synonym of this plant. A similar plant, *Actæ'a spicat'a*, furnishing a rhizome resembling black snakeroot, is common in Europe; it differs, however, in having juicy berries instead of dry follicles.

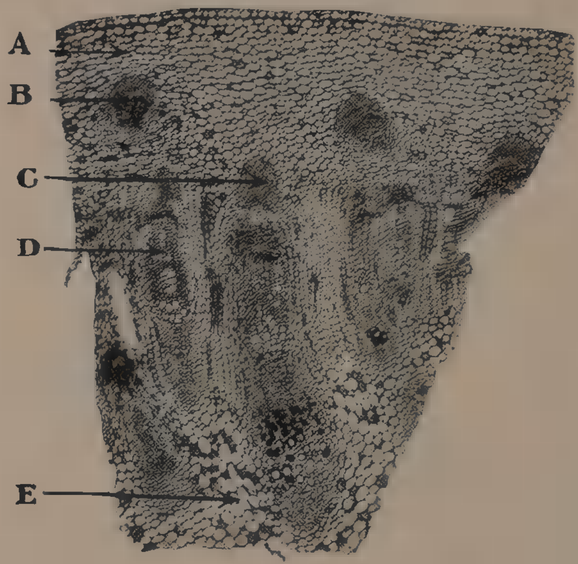

FIG. 2.—Cimicifuga—Cross-section of Rhizome. (18 diam.) A, Parenchyma of cortex. B, Vascular bundle. C, Group of bast fibers. D, Xylum. E, Medulla. (Photomicrograph.)

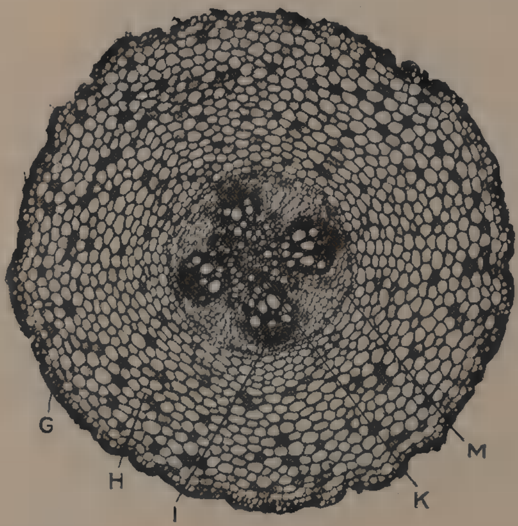

FIG. 3.—Cimicifuga rootlet—Cross-section. (26 diam.) G, Cork. H, Parenchyma of cortex. I, Phloëm. K, Xylem. M, Endodermis. (Photomicrograph.)

DESCRIPTION OF DRUG.—A short horizontal rhizome from 10 to 25 mm. ($\frac{2}{5}$ to 1 in.) thick, with numerous branches,—remains of aërial stems,—each terminated by a deep cup-shaped scar; on the lower side are found **numerous brittle rootlets** from 1 to 2 mm. ($\frac{1}{25}$ to $\frac{1}{12}$ in.)

thick; **externally** brownish-black; fracture of rhizome, horny; odor slight (the powder, however, has a heavy odor); taste bitter and acrid. **Cross-section** of the rhizome exhibits a large, whitish pith, around which, more or less stellately arranged, are wood-wedges separated by medullary rays. Bark hard and thickish. The rootlets display, under the microscope, a thick cortical layer, the space within which contains converging wedges of open, woody tissue, three to five in number, forming a Maltese cross. The stellate arrangement of the woody wedges of the rootlets is one of the best distinguishing characteristics.

Powder.—Dark brown. Characteristic elements: The cells of parenchyma of cortex, large with spherical starch grains (3 to 10 μ in diam.); numerous wood fibers, short, thick; large ducts; thick-walled cells of periderm with reddish-brown color; spherical starch grains.

CONSTITUENTS.—Besides the ordinary vegetable principles,—fat, sugar, tannin, and starch,—there exists a **resin** which has been by some assigned as the active medicinal constituent. This resin, amounting to about 3½ per cent., is contained in the resinoid **cimicifugin** or **macrotin** of the market. An acrid, crystalline principle, soluble in chloroform, ether, and alcohol, and not precipitated by lead acetate, is also said to exist in the root.

Preparation of Cimicifugin.—By precipitating the concentrated tincture with water, a crude article is prepared which is known as the resinoid. A purer form is made by precipitating the tincture of the fresh drug with lead subacetate, removing the lead from solution with H_2S, and evaporating. Soluble in alcohol and chloroform.

ACTION AND USES.—Antispasmodic, diaphoretic, and expectorant. It acts like digitalis on the circulation, and as a sedative upon cardiac ganglia; small doses stimulate digestion and secretion; used in rheumatism and disturbances of the menstrual function. It is a powerful uterine stimulant. Dose: 15 to 30 gr. (1 to 2 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Cimicifugæ, ...	Dose: 5 to 30 ♍ (0.3 to 2 Cc.).
Extractum Cimicifugæ, ...	3 to 5 gr. (0.2 to 0.3 Gm.).
Tinctura Cimicifugæ (20 per cent.),...	15 to 60 ♍ (1 to 4 Cc.).

2. HYDRASTIS.—HYDRASTIS.

GOLDEN SEAL. YELLOW PUCCOON. *Ger.* CANADISCHE GELBWURZEL.

The dried rhizome and roots of **Hydras'tis canaden'sis** Linné.

BOTANICAL CHARACTERISTICS.—Plant about 8 inches high, from a thick, knotty rhizome. The single radical leaf simple, 5-lobed; *stem* 2-leaved at summit;

flowers terminal, single, greenish; *calyx* of 3-petaloid sepals, regular; *fruit* a head of 1–2-ovuled berries.

SOURCE.—The area of the country over which hydrastis grows in sufficient abundance to be a commercial source of the drug is embraced, according to Lloyd, in four states: Ohio, Indiana, Kentucky, and

FIG. 4.—*Hydrastis canadensis.*

West Virginia. It is also found abundantly in other portions of the Eastern United States.

DESCRIPTION OF DRUG.—A knotty, contorted rhizome about 40 mm. ($1\frac{3}{5}$ in.) long and 5 mm. ($\frac{1}{5}$ in.) thick; on the upper side are several scars which mark the positions and detachment of former herbaceous stems; these scars (cup-like projections) have given rise to the name "golden seal." **Externally** rough, of a dull yellowish-brown color, annulate, and beset with numerous slender rootlets; **internally** of

a lemon-yellow color; breaks with a short, resinous fracture; a **cross-section** shows a thick bark, narrow wood-wedges, and broad medullary rays which radiate from a large pith. The rootlets show a woody center surrounded by a thick parenchymatous cortical tissue which is bordered by an outer row of compressed cells; odor distinct; taste bitter. **The drug should contain not less than 2.5 per cent. of white alkaloid, hydrastine, when assayed by the official process.** Two hundred thousand to 300,000 pounds of the drug are annually consumed.

Powder.—Bright yellow. Characteristic elements: The spherical starch granules (4 to 10 μ in diam.); ducts with simple pores; tracheids short, thick-walled; dark brown cork cells; bright yellow resin in many cells. (Highly magnified starch grains of Hydrastis, see Fig. 377.)

CONSTITUENTS.—The two alkaloids, **hydrastine,** $C_{21}H_{21}NO_6$ (colorless and slightly acrid), and **berberine** (yellow and intensely bitter),

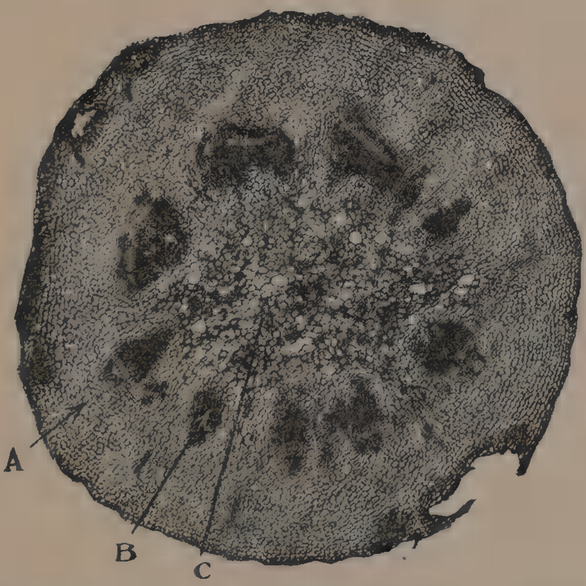

FIG. 5.—Hydrastis—Rhizome, cross-section. (18 diam.) A, Cortex. B, Vascular bundle. C, Medulla. (Photomicrograph.)

are the principal constituents. **Berberine,** $C_{20}H_{17}NO_4$, **is very widely distributed in nature,** being found in drugs from several different families of plants. **Hydrastine, when pure, is in perfectly colorless,** very brilliant, glassy crystals. As a rule, however, they are white and opaque, owing to the presence of numerous fractures. The yellow color of berberine adheres very tenaciously to the hydrastine, so that the absolutely colorless hydrastine is difficult to obtain. **Canadine,** $C_{20}H_{21}NO_4$, tetrahydroberberine, the sulphate of which is soluble in water and alcohol. **The resinoid, hydrastin, should not be confounded with the active alkaloid.** This resinoid is made by

precipitating a concentrated alcoholic tincture of hydrastis with acidulated water, and is probably, in the main, an impure muriate of berberine. Hydrastinine, which Falk regards as a valuable remedy, is made by decomposing the alkaloid, hydrastine, with dilute nitric acid and gentle heat, when opianic acid is also formed.

Preparation of Hydrastine.—Percolate drug with water; precipitate berberine by adding HCl; to filtrate add ammonia in excess. The impure hydrastine which then deposits is dissolved in alcohol, filtered through charcoal, and crystallized.

Preparation of Berberine.—(Obtained also from Berberis vulgaris and allied drugs.) Exhaust powdered root with boiling water, evaporating to soft extract; exhaust this with alcohol; add water. Distil off alcohol; add H_2SO_4 in excess, when berberine sulphate crystallizes in yellow needles.

ACTION AND USES.—Until the introduction of the white alkaloid, hydrastine, the drug was used almost exclusively as a local astringent; but of late years, since the many physiological experiments with this alkaloid, it has been used internally in chronic inflammations of the mucous membrane. Dose: 30 gr. (2 Gm.). Hydrastine is said to have antiperiodic properties and is given in doses of $\frac{1}{32}$ gr. (0.002 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Hydrastis, ...Dose: 5 to 30 ♏ (0.3 to 2 Cc.).
Tinctura Hydrastis (20 per cent.),....... 10 to 60 ♏ (0.6 to 4 Cc.).
Glyceritum Hydrastis (each Cc. contains 1 Gm. of drug). Used externally.

3. **ACTÆA ALBA.***—WHITE COHOSH. The rhizome of **Actæ'a alb'a** Bigelow. *Habitat:* Southern and Eastern United States. Often found in the European market mixed with black hellebore; its appearance, however, is more like cimicifuga. Violent purgative, irritant, and emetic.

4. **COPTIS.**—GOLD THREAD. The herb of **Cop'tis trifol'ia** Salisbury. *Habitat:* Northern and Eastern United States. The drug as found in commerce consists mainly of long, thread-like, yellow rootlets, attached to a slender, terete rhizome, mixed with trifoliate leaves. Contains *berberine* and a white alkaloid resembling hydrastine. Tonic. Dose: 15 to 60 gr. (1 to 4 Gm.) in decoction.

5. **HELLEBORUS NIGER.**—BLACK HELLEBORE. The rhizome and roots of **Helle'borus ni'ger** Linné. *Habitat:* Central and Southern Europe. Irregular and knotty; externally brown-black; internally grayish, with a thick bark; taste sweetish, bitter, and acrid; odor slight, peculiar. Poisonous; anthelmintic, drastic cathartic, and emmenagogue. Dose: 5 to 20 gr. (0 3 to 1.3 Gm.).

6. **HELLEBORUS VIRIDIS.**—GREEN HELLEBORE. The rhizome and roots of **Helle'borus viri'dis** Linné. This resembles above, but is smaller. Used as a diuretic, cathartic, and emmenagogue. Dose: 5 to 20 gr. (0.3 to 1.3 Gm.). It should not be confounded with veratrum viride (also called green hellebore), a cardiac and nervous sedative.

7. **XANTHORRHIZA.**—YELLOW-ROOT. The rhizome of **Xanthorrhi'za apiifol'ia** L'Heritier. *Habitat:* Southern and Central United States. About 500 to 1000 mm. (20 to 40 in.) long, and 10 mm. ($\frac{2}{5}$ in.) thick; externally

* Drugs treated of in small type and solid paragraphs are unofficial.

of a bright yellowish-brown color; internally yellow; inodorous and bitter. Contains *berberine*, the alkaline base of berberis vulgaris; it is a matter of record that in many, perhaps most, berberine-yielding plants, **a colorless alkaloid accompanies berberine,** but, according to Lloyd, a second alkaloid **does not exist in this drug.** Used as a tonic. Dose: ½ to 1 dr. (2 to 4 Gm.).

8. **PULSATILLA.**—PASQUE FLOWER. The herb of **Anem'one pulsatil'la** and of **Anem'one praten'sis** Linné, collected soon after flowering. Off. U. S. P., 1890. The drug never comes into the market in a condition in

FIG. 6.—*Anemone pratensis.*

which the leaf or other parts are readily recognizable, as they are most always broken or compressed. The U. S. P., 1890, directed that the herb should be carefully preserved, and not kept longer than one year. Even the drying of the plant is said to render the drug unreliable. *Constituents:* A peculiar acrid crystallizable principle exists in the plant known as **anemonin** ($C_{10}H_8O_4$), **an acrid, unstable principle** not well understood. Some authorities state that it undergoes decomposition after its solution, under conditions that are not precisely known, into anemonic acid ($C_{10}H_{10}O_5$) and anemoninic acid ($C_{10}H_{12}O_6$), etc.; others state that it is a volatile, fluid, acrid principle, very susceptible of decomposition.

Preparation of Anemonin.—If aqueous distillate be treated with chloroform, the latter, on evaporation, yields a residue—anemonin. Dose: 1½ to 3 gr. (0.1 to 0.2 Gm.).

Diuretic, diaphoretic, mydriatic, irritant. The action of pulsatilla is said to resemble aconite as a cardiac sedative. One author says it is equivalent to senega in convulsive coughs and in bronchitis. The recent tincture, in 5-drop doses (made according to the formula of the tincture of recent herbs, U. S. P., 1890), is highly esteemed by some practitioners. The drug is not infrequently classed among the most useful emmenagogues. Dose: 1 to 5 gr. (0.065 to 0.3 Gm.).

9. **ADONIS VERNALIS.**—FALSE HELLEBORE. The herb of **Adon'is vernal'is** Linné. This rather obscure drug owes its poisonous quality and medicinal activity to a glucoside, **adonidin,** whose physiological action seems to be almost identical with that of digitalin, except that it is more powerful, and not cumulative. Like digitalis, it is used in heart disease and dropsy, slowing the heart's action, and making it more regular and forcible; it greatly increases urinary secretion. Dose: 2 to 10 gr. (0.12 to 0.6 Gm.), in infusion.

10. **Ranunculus.**—CROWFOOT. BUTTER CUP. The herb of **Ranun'culus bulbo'sus** Linné. *Habitat:* Europe and North America. Base of stem thick; flowers yellow, the ovaries of which form akenes with a short, curved beak; inodorous, with acrid taste. Used externally as an irritant.

11. STAPHISAGRIA.—STAPHISAGRIA.

STAVESACRE. *Ger.* STEPHANSKORNER.

The ripe seed of **Delphin'ium staphisag'ria** Linné.

BOTANICAL CHARACTERISTICS.—*Stem* 3 to 4 feet high, erect, more or less colored purple; *leaves* long petiolate, alternate, palmately 5–9-divided, blotched with purple; *flowers* in loose spoke-like racemes, varying from light-blue to purple; irregular; *sepals* 5, petaloid, upper one prolonged into a spur; *petals* 4, small; *fruit* 3 hairy follicles.

SOURCE.—This herb is a native of Italy, Greece, the Greek Islands, Asia Minor, Mediterranean regions, and Canary Islands. It was introduced into England in 1596.

DESCRIPTION OF DRUG.—About 5 mm. ($\frac{1}{5}$ in.) long, 3 to 4 mm. ($\frac{1}{8}$ to $\frac{1}{6}$ in.) thick; **externally** flattish, tetrahedral, the broadest side convex; testa brownish, with reticulate ridges, rough and deeply pitted; **internally** it contains a whitish, oily albumen, inclosing a small, straight embryo in its sharper end. The outer layer of the testa is made up of thin-walled, narrow cells, which become larger near the edges of the seed and in the superficial wrinkles. They contain a small number of minute starch granules. The interior layer exhibits a single layer of small, densely-packed cells. The albumen is composed of the usual tissue loaded with granules of albuminoid matter and drops of fatty oil. Nearly inodorous; taste bitter and astringent. Dose 1 gr. (0.06 Gm.).

Powder.—Dark greenish. Characteristic elements: The angular cells of the parenchyma of the endosperm with aleurone and oil globules; very large epidermal cells, brown, thick-walled, with irregular thickenings.

CONSTITUENTS.—Besides fixed oil, etc., one of the most prominent constituents **is a poisonous alkaloid, delphinine,** which exists in the form of a malate. This alkaloid, however, is said to be **composed of several distinct principles.** Marquis has separated four distinct alkaloids from the seed.

FIG. 7.—*Delphinium staphisagria*—Flowering branch and seed *a*.

Preparation of Delphinine.—Treat the decoction with magnesia, exhaust the precipitate with alcohol, and evaporate. The crude alkaloid thus obtained consists of three distinct principles—resin, staphisagrine, and delphinine. Pure delphinine is soluble in alcohol and ether.

ACTION AND USES.—Stavesacre is mostly used as a parasiticide to destroy vermin, especially against pediculi vestimentorum—inhabiting the garments next to the skin. A tincture in cologne spirit has been used in some districts as a substitute for tincture of cocculus indicus, applied to the scalp as an antiparasitic. Internally, the action resembles

aconite in its effects upon the heart and respiration. Dose: 1 to 2 gr. (0.065 to 0.130 Gm.). Poisonous doses are rapidly diffused, and antidotal measures should be rapidly applied. (Fluidextractum U. S. P. 1900.)

12. **DELPHINIUM.**—LARKSPUR SEED. The seed of **Delphin'ium consol'ida** Linné. *Habitat:* Central Europe; cultivated and naturalized in some parts of the United States. A flattish, tetrahedral seed, 1 to 1.5 mm. ($\frac{1}{25}$–$\frac{1}{16}$ in.) broad; edges sharp, testa black and roughly pitted; internally, it consists of whitish, oily albumen, inclosing a small, straight embryo; inodorous; taste bitter and acrid; contains **delphinine.** Used as a diuretic, cathartic, and emetic; poisonous. Dose: $\frac{1}{2}$ to 3 gr. (0.03 to 0.2 Gm.).

13. **NIGELLA.**—NIGELLA. The seeds of **Nigel'la damasce'na** Linné. *Habitat:* Levant; cultivated. Triangular-ovate, about 2.5 mm. ($\frac{1}{10}$ in.) long; testa brittle, dull-black; embryo straight and small, with pointed ends. It has a strawberry-like odor, and bitter taste. Used as an emmenagogue and diuretic.

14. ACONITUM.—ACONITE.

MONKSHOOD. *Ger.* MONCHSKAPPE.

The dried tuberous root of **Aconi'tum napel'lus** Linné. Collected in autumn; yielding, by official assay, not less than 0.5 per cent. of aconitine.

BOTANICAL CHARACTERISTICS.—*Stem* 3 to 4 feet high, smooth and erect; *leaves* nearly sessile, alternate, palmately 5-divided; *root-leaves* long-petioled; *flowers* deep violet, irregular, very showy, in racemes; *sepals* 5, petaloid, the upper one hooded or helmet-shaped; *petals* 2, concealed.

SOURCE AND VARIETIES.—This genus of poisonous herbs, including a number of species, is found throughout cold, mountainous districts of Europe, in the Himalayas, and in Northwestern North America. It is one of the oldest and commonest plants of the English garden, and is often found in dangerous proximity to horseradish (Royle). Hindu writers mention no less than eighteen different kinds of "bish"—the vernacular for aconite. Ten of these are said to be unfit for medicinal use on account of their extremely poisonous nature, which is exaggerated to such an extent as to say that their touch is fatal. The root (tuber) of *A. napellus* is the source of the medicinal preparations of this drug, although formerly the leaves were official as well. *A. ferox* is called *bish* in India, more commonly. Nepaul aconite is the source of the extremely active alkaloid, *pseudaconitine* (see below). It is a bolder root than that imported from Germany. Therapeutically, it resembles the *napellus*, but is more diuretic and less antipyretic and diaphoretic. *A. fischeri* produces Japanese aconite root. It yields japaconitine, stated to be identical with aconitine. *A. japonicum*, with yellowish-white flowers, has been identified as a variety of *A. lycoctonum*. *A. heterophyllum*

produces a non-poisonous root, known in India as *atis*, or *atees*. It is tonic and possibly aphrodisiac. It contains a large quantity of starch.

DESCRIPTION OF DRUG.—Almost napiform, abruptly tapering, from 40 to 100 mm. long, about the thickness of a finger at the top, which is tuberculated; **externally** dark-brown, wrinkled longitudinally at lower portion, stem scars visible, rootlets usually detached; **fracture**

FIG. 8.—*Aconitum Napellus*—Flowering branch and tuber.

short, horny or starchy, exhibiting sometimes a spongy or resinous, white, grayish, or brownish tissue; taste at first sweetish, then acrid and tingling, followed by numbness. This peculiar **tingling sensation to the tongue** is one of the most prominent characteristics upon which the toxicologist depends for the recognition of this drug and its preparations. At the upper portion of the root there often projects a lateral branch connecting a second tuber, which is an offspring of

the other. A **cross-section** of the tuber shows a thick bark and **a pith often in the form of a star,** the two being separated by a nucleus sheath; the cambium, following the outline of the pith, is also **5- to 7-angled,** and at the terminal and basal extremities of each **ray** are found small groups of vascular bundles; these, however, are inclined to follow the whole cambium line. **The drug should contain not less than 0.5 per cent. of aconitine.**

Powder.—Brown; giving yellow color with KOH; deep red with H_2SO_4. Characteristic elements: Starch grains nearly spherical (4 to 12 μ in diam.) with a few compound granules; stone cells (10 to 80 μ in diam.) accompanying thick-walled parenchyma. (Highly magnified starch grains, see Fig. 373.)

FIG. 9.—Aconite tuber—Cross-section. (14 diam.) A, Cork. B, Parenchyma of cortex. C, Vascular bundle. D, Medulla. (Photomicrograph.)

ADULTERANTS.—With allied aconite roots, defective roots, and horse-radish. The root of European masterwort resembles aconite root, but it is aromatic and pungent.

CONSTITUENTS.—The principal constituent is **aconitine,** $C_{34}H_{47}NO_{11}$ (0.5 per cent.), forming about one-third the total alkaloid of the root. This is white, usually amorphous, but with difficulty may be obtained in rhombic, tabular crystals; almost insoluble in cold water, soluble in alcohol, ether, and diluted acids. Other related principles exist in the drug **combined with aconitic acid** ($H_3C_6H_3O_6$), but our knowledge of them is not satisfactory. The crystallized alkaloid only is now official in the B. P. It has the composition of acetyl benzoylaconine, melts at 189° to 190° C., and yields acetic acid at slightly higher temperature.

Pseudaconitine, $C_{36}H_{49}NO_{12}$, from *Aconitum ferox*, is highly poisonous. Atisine, $C_{22}H_{31}NO_2$ (from *Aconitum heterophyllum*), does not present any close analogy to the alkaloids of the other and well-known species of aconite (*A. napellus*, *A. ferox*, and *A. japonicum*). In small doses it is said to be non-toxic, but its action, according to some reports, resembles that of aconite.

Commercial aconitine contains some of the allied principles, which are separated from the alkaloid with difficulty.

Preparation of Aconitine.—After extracting oil and resin by a suitable solvent, an alcoholic extract is made which is treated with hot water. The aqueous solution is precipitated by adding NH_4OH in excess. This precipitate is ex-

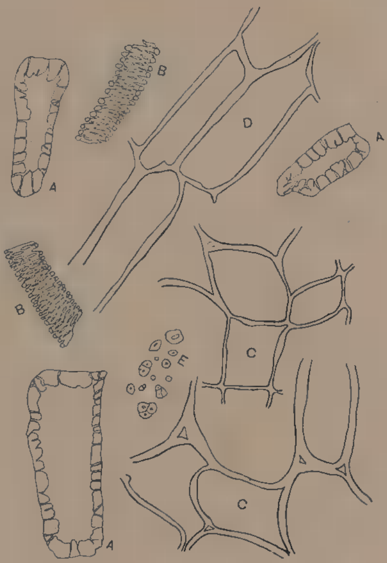

FIG. 10.—Powdered Aconite Tuber. (100 diam.) A, Stone cells. B, Fragments of water tubes. C, Parenchyma, cross-section. D, Parenchyma, longitudinal section. E, Starch.

hausted with ether—ethereal solution distilled to dryness. Purify residue by dissolving in acidulated (H_2SO_4) water, again precipitating with NH_4OH, etc. This process yields a commercial product which is not free from pseudo-aconitine.

ACTION AND USES.—A powerful depressant of the sensory nerve-ends, the heart, the respiration, and spinal system. It relaxes the inhibitory apparatus of the heart, and paralyzes the cardiac muscle and its contained ganglia, the respiratory centers, and the spinal cord in all its functions,—sensory, reflex, and motor,—but does not affect the cerebrum. Murrell has called attention to the fact that the English alkaloid is seventeen times stronger than the German, while the French is variable, but generally between these; the crystalline variety (Duquesnel's or Merck's aconitine) is therefore to be preferred on

account of its uniform strength. The dose of the commercial aconitine is $\frac{1}{64}$ gr.; the crystallized alkaloid, however, is given in doses of only from $\frac{1}{300}$ to $\frac{1}{250}$ gr., cautiously repeated (Shoemaker).

Dose of drug: 1 gr. (0.06 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Aconiti,..........Dose: ¼ to 2 ♏ (0.015 to 0.12 Cc.).
Extractum Aconiti (U. S. P., 1890), ⅙ to ⅓ gr. (0.010 to 0.02 Gm.).
***Tinctura Aconiti** (10 per cent.),.... ½ to 4 ♏ (0.03 to 0.25 Cc.).*

15. **HEPATICA.**—LIVERWORT. The leaves of **Anem'one hepa'tica** Linné. *Habitat:* North America and Europe. Heart-shaped, about 50 mm. (2 in.) long, slightly leathery; inodorous; astringent and bitter. The more correct synonym for this plant is liverleaf, as the term liverwort is applied to a family of cryptogamic, moss-like plants—*Hepaticæ*. Used as a demulcent and tonic. Dose: ½ to 2 dr (2 to 8 Gm.) in decoction.

16. **PÆONIA.**—PEONY. The root of **Pæonia officinalis** Linné. Seldom used, although at one time a popular remedy in epilepsy, diarrhea, and as an emmenagogue. Occasionally used in chorea, whooping-cough, etc. Dose: 15 to 60 gr. (1 to 4 Gm.), in infusion.

CALYCANTHACEÆ.—Calycanthus Family.

17. **CALYCANTHUS.**—FLORIDA ALLSPICE. The bark of **Calycan'thus flor'idus.** An aromatic stimulant, used in diarrhea mixtures. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

MAGNOLIACEÆ.—Magnolia Family.

Trees and shrubs, mostly of subtropical regions. *Leaves* coriaceous; alternate, simple, usually pellucid-punctate, entire, or rarely dentate; *flowers* axillary or terminal, usually solitary, perfect, or, in a few genera, unisexual; *sepals, petals, stamens,* and *pistils* numerous and hypogynous. *Fruit* various, cone-like, or forming a stellate group of whorl (illicium), or capsular with ventral or dorsal dehiscence.

Synopsis of Drugs from the Magnoliaceæ.

A. *Fruit.*
Illicium, 18.

B. *Barks.*
Magnolia, 19.
Wintera, 20.
Liriodendron, 21.

18. **Illicium.**—STAR ANISE. The dry fruit of **Illi'cium ve'rum** Hooker filius. Off. U. S. P. 1890. The fruit is pedunculate, and consists of light, **stellately-arranged,** one-seeded carpels, which are **boat-shaped** and **united around a short central column** rising from an oblique pedicle. Each carpel is 12 or 15 mm. (½ to ⅗ in.) long, woody, wrinkled, with a straight beak; rusty-brown in color, and split at the ventral suture, exposing the flattish, bright, glossy-brown, oval seed; odor intermediate between fennel and anise; taste (residing in the carpel), aromatic and sweet; **seed not aromatic,** but oily. Adulterated with *Illicium religiosum* Siebold (found

* This preparation has been changed from 35 per cent. to 10 per cent. Great care must be taken not to use the 1890 strength for the 1900.

growing around Buddhist temples in southwest China, whence its name), a poisonous plant cultivated in China and Japan, which resembles it in appearance, but is more woody, has a curved beak, a clove-like odor, and a disagreeable taste. *Constituents:* A volatile oil resembling the oil of pimpinella anise. The former oil is solidified at 35° C., and the latter between 50° and 60° C., almost entirely composed of anethol ($C_{10}H_{12}O$), with small amounts of terpenes, safrol, anisic acid, etc.

It has stimulant, anodyne, diuretic, and carminative properties which reside exclusively in the volatile oil. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

FIG. 11.—*Illicium verum*—Flowering branch and fruit.

19. **MAGNOLIA.**—MAGNOLIA. The bark of **Magno'lia glau'ca** Linné. *Habitat:* Middle and Southern United States. A thin-quilled bark of a gray color, or sometimes light brown, fissured, and covered with numerous scattered warts; the inner surface smooth and of a light brown color; fracture short, toward the inner portion somewhat fibrous; nearly inodorous, with a bitter, spicy, and pungent taste. It contains a volatile oil, resin, tannin, coloring matters, gum, and a crystalline glucoside, **magnolin.** Used as a diaphoretic, tonic, and febrifuge. Dose: 10 to 80 gr. (2 to 4 Gm.) in decoction.

20. **WINTERA.**—Winter's Bark. From **Dri'mys winte'ri** Forster, a South American tree. It has an aroma similar to that of canella and cinnamon, for which drugs it has been substituted, and is known in some places as Winter's Cinnamon. The bark of *Drimys granatensis* from New Granada is said to have been offered as Coto bark. It also has an astringent, pungent, as well as aromatic taste. Dose: 15 to 30 gr. (1 to 2 Gm.).

Fig. 12.—Flowering branch of *Liriodendron tulipifera*.

21. **LIRIODENDRON.**—Tulip-tree Bark. From **Lirioden'dron tulipi'fera** Linné. *Habitat:* United States westward to Kansas. In quills and curved pieces obtained from the branches. These quills and pieces are about 2 mm. ($\frac{1}{12}$ in.) thick; outer surface purplish-brown, with thin ridges forming elongated meshes; nearly inodorous; taste pungent and bitter. Tonic, febrifuge and vermifuge. Dose: 1 to 2 dr. (4 to 8 Gm.) in infusion or fluid extract.

Preparation of Liriodendrin.—Concentrate the alcoholic tincture; add water until a permanent turbidity commences to appear. Set aside to evaporate spontaneously. It forms, when purified, white needles or small scales. Insoluble in water, soluble in ether and alcohol.

MENISPERMACEÆ.—Moonseed Family.

Woody climbers, mostly tropical, with peltate or palmate alternate exstipulate *leaves*, and small diœcious, greenish, or whitish *flowers* in axillary panicles. *Sepals* and *petals* alike, in three rows,—the petals sometimes wanting. The *stamens* equal or exceed the petals in number. *Pistils* 2 to 6, with nearly straight ovaries, which, however, are incurved in fruiting, so that the seed is either a crescent or a ring.

Synopsis of Drugs from the Menispermaceæ.

A. *Roots.*	B. *Rhizome.*	C. *Fruit.*
CALUMBA, 22.	Menispermum, 24.	Cocculus, 25.
PAREIRA, 23.		

22. CALUMBA.—Calumba.

COLUMBO. *Ger.* KALUMBAWURZEL.

The dry root of **Jateorrhi'za palma'ta** Lamarck.

Botanical Characteristics.—Underground stem a short, irregular rhizome, from which start numerous fleshy fusiform roots 1 to 4 inches in diameter. *Leaves* palmate, on long petioles. According to Bentley and Trimen, the

blade of the leaf often reaches fourteen inches in length. *Flowers* diœcious, *sepals* 6, *petals* 6, *stamens* 6; *anthers* 2-celled; *fruit* about the size of a hazelnut, densely clothed with long, spreading hairs, each tipped with a black, oblong gland.

HABITAT.—East Africa and Madagascar; cultivated in the East Indies.

DESCRIPTION OF DRUG.—**In transverse sections,** circular or oval in outline, 25 to 50 mm. (1 to 2 in.) in diameter; 3 to 12 mm. ($\frac{1}{8}$ to $\frac{1}{2}$ in.) thick. The outer edge is covered with a brown wrinkled layer of cork. The bark is about 9 mm. ($\frac{3}{8}$ in.) thick; a dark,

FIG. 13.—*Jateorrhiza palmata*—Portion of vine.

shaded cambium line separates this bark from the **spongy grayish-yellow meditullium.** In drying the central portion contracts more than the outer, hence the disks are depressed at this point, where also are found a few interrupted circles of projecting wood-bundles, while the outer portion near the cambium is distinctly radiate. **A microscopic section** shows near the centre very **distinct bright yellow wood-bundles,** which are **narrow and radiate near the bark.** The parenchyma is filled with large, oval or circular starch granules. Odor faint; taste slightly aromatic, very bitter, and mucilaginous. Dose: 30 gr. (2 Gm.).

Powder.—Yellowish. Characteristic elements: Parenchyma with characteristic starch grains (25 to 50 μ in diam.); ducts, large, reticulate or pitted; sclerenchyma consisting of stone cells, thin-walled, with prismatic calcium oxalate crystals. (Starch grains highly magnified, see Fig. 369.)

CONSTITUENTS.—A neutral crystalline principle, **calumbin,** extremely bitter, **berberine, calumbic acid,** and starch, of which it contains 33 per cent. **No tannin is present;** it can therefore be compounded with salts of iron. The best solvent for the bitter principle is dilute acetic acid. This liquid, however, is not a good menstruum.

Preparation of Calumbin.—Infusion of columbo, made with 3 per cent. of oxalic acid, is neutralized with ammonia. Evaporate to one-third, and when cool, shake out with ether. On evaporation of ethereal solution, white calumbin is obtained.

FIG. 14.—Columbo—Cross-section of root. (1.5 diam.) A, Annual ring of growth. B, Medulla. (Photograph.)

ACTION AND USES.—A simple tonic, stimulating the appetite through the gustatory nerves, increasing in turn the gastric and salivary secretions. Its special value as a tonic resides in the fact that it has no disagreeable effects, such as nausea, headache, or febrile disorder, like other remedies of its class. Externally, antiseptic, disinfectant, and anthelmintic.

OFFICIAL PREPARATIONS.

Fluidextractum Calumbæ,............Dose: 5 to 30 ♏ (0.3 to 2 Cc.).
Tinctura Calumbæ (20 per cent.),....... 1 to 4 f℥ (4 to 15 Cc.).

23. PAREIRA.—Pareira.

PAREIRA BRAVA. *Ger.* GRIESWURZEL.

The dry root of **Chondoden'dron tomento'sum** Ruiz et Pavon.

Botanical Characteristics.—A vine with twining stem 4 inches in diameter; *leaves* large, cordate, long-petioled, with entire margins; *flowers* diœcious; *fruit* purplish, ovoid, 1-seeded, drupaceous, forming thick clusters resembling bunches of grapes.

Habitat.—Brazil.

Description of Drug.—**A long, branching, woody root,** found in commerce in tortuous, subcylindrical pieces, about 100 to 150 mm. (4

Fig. 15.—Pareira—Cross-section of root. (1.5 diam.) A, E, F, Xylem. B, Phloëm. C, G, Rings of stone cells. (Photograph.)

to 6 in.) long, and from 20 to 100 mm. ($\frac{4}{5}$ to 4 in.) thick. **Externally** it varies from brown to light grayish-brown in color, and is marked with fissures, transverse ridges, and longitudinal wrinkles. When cut or sliced it displays a dark brown interior, leaving under the knife a waxy luster. **A cross-section** displays a thin bark; within this bark circle there are two or more circles (zones) of radiating

wood-wedges. About 12 of these wood-wedges are found in the central zone radiating from a common center. The outer **circles (zones) of wood-wedges are separated from one another by a narrow line of parenchyma,** stone cells, and compressed cells, and the short, circular, radiating **wedges of wood are separated from one another by medullary tissue,** making a combination of concentric and radiate arrangement which is quite characteristic. Sometimes sections of the stem are found in the drug; these have a rather thick

FIG. 16.—Cross-section of Menispermum—Magnified 14 diam.

bark and a narrow pith. Taste at first mild, then bitter and somewhat acrid; odorless.

Powder.—Brownish yellow. Characteristic elements: Starch, ellipsoidal, simple or 2 to 4 compound (7 to 15 μ in diam.); sclerenchyma consisting of long bast fibers and numerous isodiametric or elongated stone cells 20 to 50 μ across; wood fibers, simple or bordered pits; cork, dark brown cells (20 to 25 μ in diam.); calcium oxalate, in rosettes, few.

CONSTITUENTS.—Pelosine (cissampeline), amorphous, insoluble in hot or cold water, soluble in alcohol and chloroform; taste sweetish-bitter.

Preparation of Pelosine (also known as Cissampeline).—Boil root in acidulated H_2SO_4 water, precipitate with K_2CO_3, purify by redissolving in acidulated water, decolorize with charcoal, again precipitate with K_2CO_3, and purify from solution in ether.

ACTION AND USES.—As a remedial agent pareira is generally conceded to be beneficial as a diuretic and tonic in the treatment of cystitis

and suppurative kidney diseases, acting in a soothing manner, especially on the bladder. Formerly renowned as a lithontriptic. Dose: 30 to 60 gr. (2 to 4 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Pareiræ, ...Dose: ½ to 2 f℥ (2 to 8 Cc.).

24. **MENISPERMUM.**—YELLOW PARILLA.—The dry rhizome and roots of **Menisper'mum canaden'se** Linné. Rhizome about 1000 mm. (40 in.) or more long, and 6 mm. (¼ in.) thick; **externally** dark yellowish-brown, knotty, and longitudinally wrinkled; fracture woody and tough; nearly

FIG. 17.—*Anamirta cocculus*—Flowering branch. *a*. Fruit. *b*. Section of same.

inodorous; taste bitter Rootlets thin, brittle, yellow. A **cross-section** of the rhizome displays a thick bark and a yellowish interior. Under the microscope are seen **numerous wood-wedges separated by narrow medullary rays;** at the extremity of each wood-ray there appears a semilunar bundle, which on longitudinal section proves to be composed of bast fibers penetrating the bark. The diameter of the pith varies, not infrequently occupying one-third of the space between the bark. The overground stem, with which the drug is not infrequently mixed, has a very large, porous pith. *Constituents:* **Berberine** (yellow) in small amount, and **menispine** (white), the principal constituents, with resin, tannin, and starch. (Maisale.) Alterative, tonic, diuretic, and laxative; said to resem-

ble sarsaparilla in its action. The root was introduced into the market as Texas sarsaparilla. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

Fluidextractum Menispermi
(U. S. P. 1890) ....Dose: 5 to 30 ♏ (0.3 to 2 Cc.).

25. **COCCULUS.**—FISH BERRIES. **Coc′culus In′dicus.** The fruit of **Anamirta cocculus** Wight and Arnott. Obtained from a climbing shrub in Eastern India, native of Malabar coast. The berries are ovoid, **kidney-shaped,** and about the **size of a large pea,** with an obscure ridge around the convex back. Externally wrinkled and blackish-brown in color. **The endocarp** is white, and extends from the concave side deeply into the interior. **The seed is semilunar,** oily, very bitter, but the pericarp is tasteless. The chief constituent is **picrotoxin.**

Preparation of Picrotoxin.—To aqueous extract add MgO; treat this with hot alcohol. Evaporate and collect the deposited picrotoxin.

Locally employed in cutaneous affections. The decoction (or tincture added to water, 1 to 4) is used as an insecticide in head lice. **Picrotoxin is an acrid narcotic poison;** in its action on the secretions it is said to resemble pilocarpine. The berries have been used from ancient times for stupefying and capturing fish, but "this unsportsmanlike method of fishing in some parts of the country is now illegal."

Cocculus indicus has been sometimes confounded with the fruit of the *Laurus nobilis*, commonly known as bayberry. The latter is, however, generally larger, distinctly oval in form, and the seeds lie loose within and fill the cavity of the fruit. The seed of the bayberry has an agreeable aromatic taste.

BERBERIDACEÆ.—Barberry Family.

Herbs, shrubs, or trees with watery juice. A peculiarity of the **leaves** in the principal genus of the order suggests the name barberry; these are usually **beset with spiny teeth,** occasionally **reduced to simple or branching spines** (barbs). **Inflorescence** various; solitary (Podophyllum), in racemes (Berberis), panicles, cymes, or spikes. **Flowers** greenish (Caulophyllum) or white with outer greenish bractlets (Podophyllum); **fruit** a berry or capsule (sometimes edible—May apple).

Synopsis of Drugs from the Berberidaceæ.

A. *Rhizomes.*	B. *Roots.*	C. *Bark.*
Caulophyllum, 26.	Berberis Radix, 29.	Berberis cortex, 30.
PODOPHYLLUM, 27.	**BERBERIS**, 31.	
Jeffersonia, 28.		

26. **CAULOPHYLLUM.**—SQUAW ROOT. BLUE COHOSH. The rhizome and roots of **Caulophyl′lum thalictroi′des** Linné. Off. in U. S. P. 1890. Rhizome crooked, of horizontal growth, about 100 mm. (4 in.) long, and 6 to 8 mm. ($\frac{1}{4}$ to $\frac{1}{3}$ in.) thick; **on the upper side are broad cup-shaped scars** and short bent branches having concave terminations; it is beset with numerous tough and **wiry light-brown rootlets matted together.** Externally of a dull brown color, **internally** whitish, **with numerous narrow wood-wedges,** sometimes **in two circles,** inclosing a large pith. The rootlets have a much thicker bark and a thick central woody cord. Nearly inodorous; taste slightly sweetish and somewhat acrid. (Highly magnified starch grains of caulophyllum, see Fig. 372.) *Constituents:* Resins, 12 per cent., tannin, starch, gum, etc. The existence of an alka-

loid, **caulophylline,** has been shown by J. U. Lloyd; this is colorless, odorless, and almost tasteless, is not precipitated by alkalies, and crystallizes with difficulty; many of its characteristics make it appear as a proximate principle belonging to a new class of bodies about which little is known.

Preparation of Caulophyllin.—Concentrate alcoholic tincture and add this to a large volume of water. Collect precipitate and dry in current of warm air.

Caulophylline.—Extract drug with 60 per cent. alcohol. Evaporate tincture to a semi-solid. Add ferric hydrate and sodium bicarbonate to this residue and extract the mixture with chloroform. The principle remains on the evaporation of the solvent. Emmenagogue, diuretic, and antispasmodic; it has some reputation in the treatment of rheumatism and as an expectorant in bronchitis. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

FIG. 18.—*Caulophyllum*—Cross-section of rhizome. *A*. Epidermis. *B*. Parenchymatous tissue. *C*. Phloëm portion of bundle. *D*, *F*. Medullary rays. *E*. Xylem portion of bundle.

27. PODOPHYLLUM.—Podophyllum.

MAY APPLE. MANDRAKE. *Ger*. FUSSBLATTWURZEL.

The dry rhizome of **Podophyl'lum pelta'tum** Linné.

BOTANICAL CHARACTERISTICS.—*Leaf* 7–9-lobed; peltate. *Flowering stem* bearing two one-sided leaves with the stalk thickest near their inner edge. *Flower* large, white, nodding. *Fruit* ovoid, slightly acid, edible.

DESCRIPTION OF DRUG.—Rhizome 300 mm. (12 in.) or more long and 5 mm. ($\frac{1}{5}$ in.) thick, jointed, consisting of nodes and internodes, the length of the internodes being about 50 mm. (2 in.). The rhizome is **very much thickened at the nodes, where it is sometimes branched** laterally, **each node having a circular scar on the upper side** and about six to ten small brittle rootlets below or scars from broken rootlets; externally smooth, slightly wrinkled longitudinally, of an orange-brown color; fracture short, white and starchy, showing a rather thick bark, and from **sixteen to thirty vascular bundles encircling a broad pith;** the parenchyma contains chiefly starch. Odor faint and characteristic; taste sweetish, slightly acrid, and quite bitter.

Powder.—Light brown. Characteristic elements: Starch grains, spheroidal, simple, 2 to 4 compound or aggregate (5 to 12 μ in diam.); parenchyma of cortex, large (35 to 40 by 80 to 200 μ in diam.), thick-walled; occasional large aggregate crystals of calcium oxalate; ducts variously marked with spiral, scalariform, reticulate, or simple pores; cork, small amount (30 to 40 μ in diam.). (Highly magnified starch grains, see Fig. 376.)

Preparation of Podophyllin.—Composed of several resinous principles separable by solvents. Ether dissolves out a resin of bright yellow color, leaving

FIG. 19.—*Podophyllum peltatum*—Plant and rhizome.

a brown, odorless resin of little more prompt activity. A concentrated tincture is precipitated by water containing HCl. (See U. S P., page 379; Resina Podophylli.) The precipitate is collected and dried.

Podophyllin is not found to any extent in the fresh drug, according to Lohman. It is developed to the fullest extent only by storage.

CONSTITUENTS.—Resins associated with other common vegetable principles; **podophyllin** (Resina podophylli, U. S. P.) 4 to 6 per cent., together with amorphous and crystalline principles. Later investigations have given prominence to the following: Podophyllotoxin,

$C_{15}H_{14}O_6$ (white crystals), converted by hydration into podophyllic acid, $C_{15}H_{16}O_7$; picropodophyllin, isomeric with podophyllotoxin

FIG. 20.—Podophyllum. Cross-section of rhizome. (15 diam.) A, Vascular bundle. B, Parenchyma of cortex. C, Medulla. (Photomicrograph.)

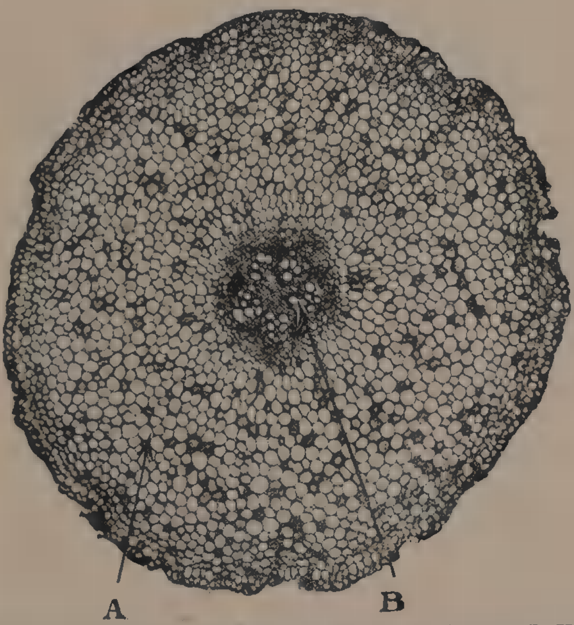

FIG. 21.—Podophyllum. Cross-section of rootlet. (25 diam.) A, Cortex. B, Xylem. (Photomicrograph.)

(inert); quercetin, yellow needles; podophylloresin (purgative). Some authorities state that the purgative principle is closely related to emodin. (See *Rhamnus purshiana.*)

ACTION AND USES.—Classed usually with the drastic cathartics. Dose: 10 to 20 gr. (0.6 to 1.3 Gm.). Podophyllin is an irritant to the mucous membrane; in small doses an active cathartic, having reputed cholagogue properties, hence the name "vegetable calomel." Dose: as a laxative $\frac{1}{10}$ gr. (0.006 Gm.), as a purgative $\frac{1}{4}$ gr. (0.016 Gm.).

There is a remarkable difference shown in the medicinal activity of podophyllin, whether precipitated by water alone, whether by acidulated water (U. S. P. process), or by solution of alum. H. J. Lohman points out the fact that it is not safe to give a larger dose than

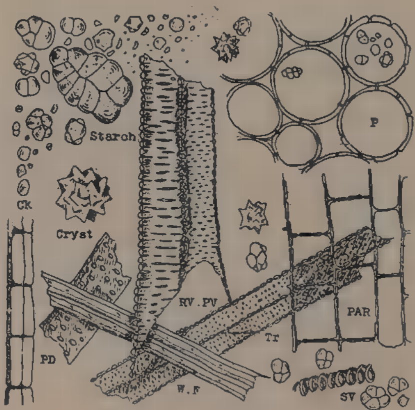

FIG. 22.—Podophyllum in powder. Starch. Cryst, Crystals of calcium oxalate. Ck, Corky tissue, side view. PD., Duct with bordered pores. RV, PV, Reticulated and pitted ducts. Tr, Tracheids. S V, Spiral vessels. W. F., Wood fibers or bast fibers. Par., Parenchyma in longitudinal view. P., Parenchyma in cross-section.—(*After Jelliffe.*)

$\frac{1}{100}$ of a grain of the resin obtained by the first process, $\frac{1}{4}$ to $\frac{1}{2}$ of a grain may be given of the product of the second process, and from 1 to $1\frac{1}{2}$ grains of that of the third process—a subject worthy of further study.

OFFICIAL PREPARATIONS.

Fluidextractum Podophylli, . . . Dose: 5 to 15 ♏ (0.3 to 1 Cc.).
Resina Podophylli, ... $\frac{1}{8}$ to $\frac{1}{2}$ gr. (0.0081 to 0.0324 Gm.).

28. **JEFFERSO'NIA DIPHYL'LA** Persoon.—TWIN-LEAF. (Rhizome.) Has properties somewhat similar to senega; it is also diuretic, alterative, and antispasmodic. Dose: 15 to 60 gr. (1 to 4 Gm.).

29. **BERBERIS RADIX.**—BARBERRY ROOT. The root of **Ber'beris vulga'ris** Linné. *Habitat:* Europe, Western Asia, and North America. Thick, much-branched, from 25 to 50 mm. (1 to 2 in.) in diameter in the thickest part; wood light yellowish, hard, tough, with a very thin bark (see Barberry Bark below); odor slightly aromatic; taste bitter. It contains five alkaloids, of which **berberine** is the most interesting. Used as a tonic in doses of 30 to 60 gr. (2 to 4 Gm.).

30. **BERBERIS CORTEX.**—BARBERRY BARK. The bark of the above root, coming in long, thin pieces, exfoliating, or separating into thin layers; outer surface yellowish-gray; inner surface bright yellow. It contains the same alkaloids as the root, but in greater proportion. This species is the

host plant for the common wheat rust (*Puccinia graminis*) in its accidio stage. The leaves when parasiticized by this fungus seem to be covered with yellow spots, the openings of the cups in which the spores are borne. Dose: 3 to 10 gr. (0.2 to 0.6 Gm.).

31. BERBERIS.

BERBERIS. (Oregon Grape.)

The dry rhizome and roots of **Ber'beris aquifo'lium** Pursh, growing in the Rocky Mountains and westward.

In more or less knotty irregular pieces of varying length and from 3 to 50 mm. in diameter; bark from 0.5 to 2 mm. thick; wood yellowish, distinctly radiate, with narrow medullary rays, hard and tough; rhizome with a small pith; odor distinct; taste bitterish

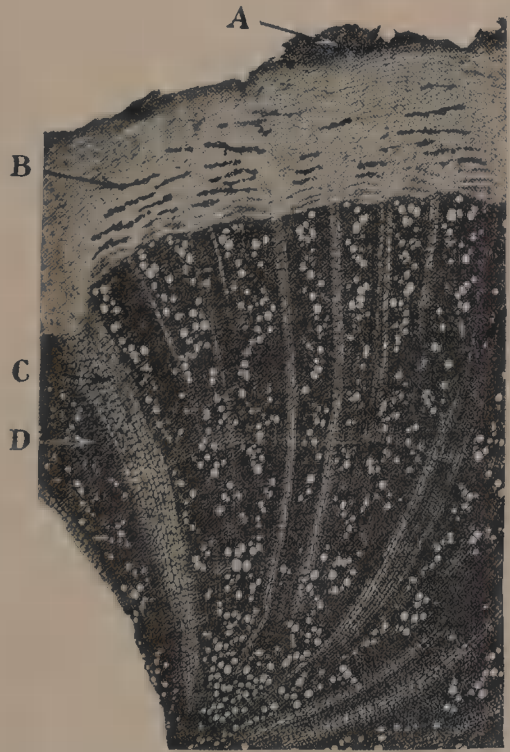

Fig. 23.—*Berberis Aquifolium.* Cross-section of rhizome. (22 diam.) A Cork. B, Group of bast fibers. C, Medullary ray. D, Xylem. (Photomicrograph.)

Constituents.—Contains three alkaloids, **berberine, oxycanthine** and **berbamine**; the two latter are white. Used as a tonic and alterative in doses of 8 to 30 gr. (0.5 to 2 Gm.). (Fluidextractum U. S. P. 1900.)

NYMPHÆÆ.—Water Lily Family.

Aquatic plants, with peltate or cordate leaves from a prostrate rhizome.

32. **NYMPHÆA.**—WATER LILY. The rhizome of **Nymphæ'a odora'ta** Aiton. *Habitat:* United States, in ponds. About 500 mm. (20 in.) long and 50 mm. (2 in.) thick, usually broken up into grayish, spongy segments, consisting mainly of parenchyma, with a few scattered wood-bundles. Inodorous; taste mucilaginous and astringent. Used as a demulcent and astringent. Dose, 15 to 30 gr. (1 to 2 Gm.).

The rhizome of **Nu'phar ad'vena** Nuttall, Yellow Pond Lily, has similar properties and uses.

SARRACENIACEÆ.—Pitcher-plant Family.

33. **SARRACE'NIA FLA'VA** and **S. PURPU'REA** Linné.—The curious pitcher-plant, fly-trap, or side-saddle plant of our Southern States, where their rhizomes are much used in dyspepsia. They are tonic and diuretic. Dose, 15 to 30 gr. (1 to 2 Gm.).

PAPAVERACEÆ.—Poppy Family.

Herbs with milky, narcotic juice. *Leaves* alternate. *Flowers* large, with caducous calyx. *Ovary* one-celled, with parietal placentæ. The genus Papaver, a description of which is given under Opium, is typical of the order. See also illustrations below.

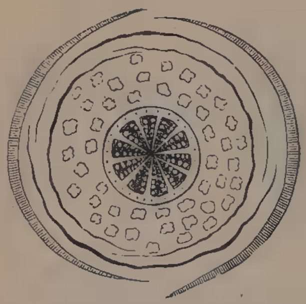

FIG. 24.—Transverse section of flower of Poppy.

FIG. 25.—Gynecium of Poppy, with one stamen remaining.

FIG. 26.—Transverse section of ovary of Poppy.

Synopsis of Drugs from the Papaveraceæ.

A. *Concrete Juice.*
OPIUM, 34.

B. *Capsule.*
Papaver, 35.

C. *Seed, and Fixed Oil.*
Papaver, 36.

D. *Herbs.*
Chelidonium, 37.
Eschscholtzia, 38.

E. *Rhizome.*
SANGUINARIA, 39.

F. *Flower-petals.*
Rhœas, 40.

34. OPIUM.—OPIUM.

OPIUM. *Ger.* MOHNSAFT.

The concrete milky exudation obtained by incising the unripe capsules of **Papa'ver somnif'erum** Linné. Containing not less than 9 per cent. of Morphine.

BOTANICAL CHARACTERISTICS.—*Leaves* large, sessile, wavy, cut, or toothed; *flowers* large and terminal, drooping before expansion; *petals* 4, large, roundish, white or purplish with a darker colored spot near the claws;

FIG. 27.—*Papaver Somniferum*—Flowering branch and fruit.

stigmas 4 to 20, radiating, sessile upon the disk, which covers the ovary. *Capsule* obovate, 1-celled; *placentæ* extended so as to almost divide the cavity into several cells; dehiscence by small chinks or pores beneath the crown formed by the radiating stigmas; *seeds* numerous, reniform.

SOURCE.—Western Asia; cultivated in the elevated plains of India, in Egypt, Persia, Asia Minor, and in some parts of Europe. Varieties:

(1) Smyrna, Levant, Turkey, or Constantinople; opium generally in flattish masses—the most abundant in the market, to which descriptions in text-books usually apply; (2) Egyptian, in flattened, roundish cakes; (3) Persian, in cylindrical sticks or cakes of a black color; (4) Indian, in flat squares, covered with layers of mica, and further protected by a coating of wax or an oiled-paper wrapper; (5) Chinese, in flat, globular cakes; (6) European.

A so-called Boston opium entered the American market a few years ago; this was really a sophisticated article. Its morphine strength was at the lowest point which would enable it to pass through the United States Custom House, and yet to have the physical appearance of high-grade opium.

Factitious opium has occasionally been met with, of soft consistence, blackish-brown color, less odorous than the genuine. It is probably an aqueous extract of the poppy plant.

Bonato states that opium is often adulterated with the aqueous extract of the capsules and seeds of *Ruta silvestris;* fresh poppy petals are also pulped and mixed with it.

Description of Drug.—**In irregular or subglobular lumps weighing from four ounces to two pounds,** enveloped in remnants of poppy leaves and with chaffy fruits of a species of *Rumex* adhering; **when fresh it is plastic,** breaking or tearing apart, showing an irregular, chestnut-brown surface, shining when rubbed; odor peculiar, narcotic; taste bitter. When examined with a pocket lens, it is seen to be composed of yellowish, agglutinated tears. **The value of the gum,** however, **is determined only by assay.** Opium should yield not less than 9 per cent.; powdered opium not less than 12, nor more than 12.5 per cent., of crystallized morphine when assayed by the official process.

Granulated opium, or coarsely powdered opium, is an article of commerce, and is especially recommended as a form of the drug best adapted to the preparation of the tinctures. A tincture made of opium in this condition is said to have a greater morphine strength than that made by the official process.

Powder.—Grayish brown. Characteristic elements: Fibro-vascular tissue absent; epidermal cells of capsule (40 μ in diam.), with scattered, brownish, irregular, granular masses.

Adulterations.—To increase the weight various articles are used, such as sand, clay, scrapings of poppy capsules, and various mucilaginous, albuminous, and saccharine matters. The writer has taken from the interior of about a two-pound lump of opium over a quarter of a pound of lead bullets.

CONSTITUENTS.—Opium contains a mixture of sixteen or more different alkaloids, with meconic acid, coloring matters, and various inert substances. The principal constituents are the following alkaloids: **Morphine,** $C_{17}H_{19}NO_3 + H_2O$; **codeine,** $C_{18}H_{21}NO_3 + H_2O$ (both official); narcotine, narceine, paramorphine, papaverine, meconidine, pseudomorphine, codamine, laudanine, and oxynarcotine; these are in combination with meconic and thebolactic acids.

Preparation of Morphine.—To the concentrated infusion of opium add three volumes of a mixture composed of one part of alcohol, two volumes of ether, and one-third volume of ammonia; shake, and set aside for crystals to form.

Preparation of Codeine.—The mother liquor, from which morphine has separated, yields crude codeine on evaporation. Obtained artificially by heating morphine with methyl iodide and soda or potassa.

Preparation of Narceine.—The concentrated infusion of opium is shaken with ether. This removes narcotine. If alkali be added in excess, codeine is deposited. From the filtrate morphine can be crystallized, and from the mother liquor narceine may be obtained upon evaporation.

Preparation of Meconic Acid.—Add $CaCl_2$ to an infusion of opium, which precipitates calcium meconate; decompose the latter by dilute HCl at 180° F. This deposits the calcium bimeconate, which is dissolved in warm concentrated HCl, from which the pure meconic acid deposits in cooling.

ACTION AND USES.—Stimulant, narcotic, anodyne, antispasmodic, and intoxicant. It restrains the movements and checks the secretions of the stomach and intestinal canal. The dominant action of opium, however, is upon the brain, **first producing mental and emotional exhilaration, then hypnotic depression.** It is a powerful respiratory depressant, death usually resulting from paralysis of the respiratory center in the medulla. Toxic doses, also, finally paralyze both the heart and vagi, and produce a rapid and feeble pulse. While the effects are due to the morphine present, the drug is not fully represented by this alkaloid. Codeine is also hypnotic, but affects the cerebrum less. Narcotine is antiperiodic. Thebaine is sudorific and excitant. Dose of opium: 1 to 2 gr. (0.065 to 0.13 Gm.).

ANTIDOTES.—Emetics, apomorphine subcutaneously injected, strong coffee and stimulants, evacuation by mechanical means (stomach-pump, etc.), or rousing and walking the patient. Atropine is the physiological antagonist.

OFFICIAL PREPARATIONS.

Opii Pulvis (12 to 12.5 per cent. Morphine), ...Dose:	$\frac{1}{4}$ to 2 gr. (0.016 to 0.13 Gm.).
Acetum Opii (10 per cent)	3 to 10 ♏ (0.2 to 0.6 Cc.).
Extractum Opii (20 per cent. Morphine), ...	$\frac{1}{4}$ to 1 gr. (0.016 to 0.065 Gm.).
Emplastrum Opii (6 per cent. extract Opium).	
Opium Deodoratum (12 to 12.5 per cent. Morphine),..........	$\frac{1}{4}$ to 2 gr. (0.016 to 0.13 Gm.).
Pilulæ Opii (1 gr. in each pill),...	1 to 2 pills.

Pulvis Ipecacuanhæ et Opii (1 gr. Opium and 1 gr. Ipecac in every 10 gr.),	5 to 10 gr. (0.3 to 0.6 Gm.).
Tinctura Opii (10 per cent.),	5 to 15 ℳ (0.3 to 1 Cc.).
Tinctura Opii Camphorata (Opium, Camphor, Benzoic Acid, and Oil of Anise, each 0.4 per cent.),	1 to 4 fl. dr. (4 to 15 Cc.).
Tinctura Opii Deodorati (10 per cent.),	5 to 15 ℳ (0.3 to 1 Cc.).
Tinctura Ipecacuanha et Opii (1 gr. Opium and 1 gr. of Ipecac in every 10 ℳ),	5 to 10 ℳ (0.3 to 0.6 Cc.).
Trochisci Glycyrrhizæ et Opii (each troche containing about $\frac{1}{12}$ gr. of Opium),	1 to 3 troches.
Vinum Opii (10 per cent.),	5 to 15 ℳ (0.3 to 1 Cc.).
Alkaloids:	
Morphina,	$\frac{1}{8}$ to $\frac{1}{2}$ gr. (0.008 to 0.032 Gm.).
Morphinæ Acetas,	$\frac{1}{8}$ to $\frac{1}{2}$ gr. (0.008 to 0.032 Gm.).
Morphinæ Hydrochloras,	$\frac{1}{8}$ to $\frac{1}{2}$ gr. (0.008 to 0.032 Gm.).
Morphinæ Sulphas,	$\frac{1}{8}$ to $\frac{1}{2}$ gr. (0.008 to 0.032 Gm.).
Codeina,	$\frac{1}{4}$ to 2 gr. (0.016 to 0.13 Gm.).
Preparations containing Morphine Sulphate:	
Pulvis Morphinæ Compositus (1.5 Gm. in 100, with Glycyrrhiza, Camphor, and Precipitated Chalk),	5 to 10 gr. (0 3 to 0.6 Gm.).

35. **PAPAVER.**—Poppy Capsules. The nearly ripe capsules, free from seeds, of **Papa′ver somnif′erum** Linné. There are two varieties, distinguished by the color of their seeds. The white poppy is usually considered the true opium plant; its capsule is smooth, of various shapes, but usually **subglobular and somewhat flattened at the extremities; it is of a gray or a light yellowish-brown color,** 50 to 100 mm. (2 to 4 in.) in diameter, **crowned with the sessile stigmas arranged in a circle;** *placentæ* parietal, projecting toward the center; odor slight; taste bitter.

Constituents.—Morphine, codeine, narcotine, narceine, papaverosine, and rhœadine, united with organic acids, of which meconic is the most important.

Action and Uses.—Hypnotic and sedative in syrup or extract; local anodyne in decoction. Dose: 15 to 30 gr. (1 to 2 Gm.).

36. **PAPAVERIS SEMEN.**—Poppy Seed. Maw Seed. The seed of **Papa′ver somnif′erum,** remarkable for containing so large a per cent. of fixed oil, which is very useful in the arts, and is also demulcent and anodyne. The seeds are less than a millimeter in length, kidney-shaped, with the surface regularly pitted, giving them a beautiful appearance under a lens. There is a black-seeded and a white-seeded variety under cultivation.

Fifty per cent. of oil is obtained from the seeds by warm and 30 per cent. by cold pressure. It is pale yellow, with a bland and slightly sweetish taste, totally destitute of narcotic properties. Poppy-seed oil is used for salads, paints, soaps, illumination, and to adulterate olive and almond oils.

37. **CHELIDONIUM.**—Celandine. The entire plant of **Chelido′nium ma′jus** Linné. Off. in U. S. P. 1890. Stem hairy, arising from a reddish-brown, branching root, and bearing light green, lyrate-pinnatifid leaves about 200 mm. (8 in.) long; odor slight; taste acrid. Cathartic, diuretic, diaphoretic, and expectorant. In certain sections it is used in the treatment of jaundice. Dose: 15 to 60 gr. (1 to 4 Gm.).

Alkaloids and Principles of Chelidonium and Allied Plants.—Important researches of J. O. Schlotterbeck have shown that chelerythrine, yielding lemon-

colored salts, exists also as a prominent alkaloid in sanguinaria and other plants of the same family. Protopine, $C_{20}H_{19}NO_5$, a frequently occurring alkaloid in the poppy family, occurs also in the plants of the fumariaceæ. In physical properties protopine agrees, in every particular, with fumarine. Protopine has been found in *Papaver somniferum*, *Eschcholtzia californica*, *Sanguinaria canadensis*, *Stylophorum diphyllum*, and *Adlumium cirrhosa;* it constitutes two-thirds of the entire alkaloidal content of *Bocconia cordata*. ("Proc. Amer. Phar.," 1900, p. 131.) Wintgen found the constituent, chelidonine, to be $C_{29}H_{10}NO_{59} + H_2O$. Schlotterbeck finds its more exact formula as, $C_{20}H_{18}(OH)NO_4 + H_2O$. ("Proc. Am. Ph.," 1903, p. 321.) It occurs in colorless monoclinic prisms, melting at 135° to 136° C. The coloring-matter, known as chelidoxanthin, found in chelidonium and stylophorum diphyllum, has been found to be identical with the alkaloid berberine. ("Pharm. Rev.," Jan., 1902, pp. 4, 5.)

38. **ESCHSCHOLTZIA CALIFORNICA** Chamisso.—(Herb.) A valuable calmative, soporific, and analgesic, "free from the disadvantages of opium." Dose of alcoholic extract: 10 gr. (0.6 Gm.), gradually increased to 3 dr. (12 Gm.) in a day.

39. SANGUINARIA.—Sanguinaria.

BLOOD ROOT. *Ger.* BLUTWURZEL.

The rhizome of **Sanguina'ria canaden'sis** Linné, dried after death of foliage.

Botanical Characteristics.—A low perennial, common in rich woods, having a thick, prostrate root-stock, surcharged with an orange-red, acrid juice, and sending up in earliest spring a rounded, palmately-lobed leaf and a one-flowered naked scape. *Flower* white, handsome; *sepals* 2; *petals* 8 to 12; *stamens* about 24; *style* short; *stigma* two-grooved; *pod* oblong, turgid, one-celled

Habitat.—Rich woods of North America.

Description of Drug.—A horizontal cylindrical rhizome about 50 mm. (2 in.) long and 10 mm. (2/5 in.) thick, slightly tapering and branched; **externally** reddish-brown, rough, wrinkled, and annulate; **internally** spongy, **dotted with small resin cells of a ruby color.** The color of a cut surface varies from a light to a very dark red, and presents a glossy, dotted appearance; bark thin, with resin cells scattered in the parenchyma; frequently the transverse surface shows either a uniform dark blood-red color, or a whitish, starchy surface scattered with numerous red dots; **odor slight; taste bitter and acrid;** the powder is sternutatory. The infusion of the drug becomes blood-red with sulphuric or hydrochloric acid.

Powder.—Brownish-red. Characteristic elements: Parenchyma of cortex with thin, reddish-brown walls and starch grains, 4 to 15 μ. Reddish-brown laticiferous ducts (secreting cells) with reddish-brown contents; ducts reticulate and spiral; cork cells containing dark brown resin.

Adulteration.—E. M. Holmes calls attention to an adulteration of *Helionas rhizome* (550), false unicorn, a rather expensive admixture

amounting, in one case, to 40 per cent. This root has a different transverse surface, being of a dirty white hue and horny texture, and exhibits a well-defined central column, occupying about one-third of the diameter, and containing irregularly placed vascular bundles.

CONSTITUENTS.—**Sanguinarine,** $C_{20}H_{15}NO_2$, **a colorless alkaloid yielding red salts,** chelerythrine yielding lemon-yellow salts, homochelidonine, and protopine. See Alkaloids, under Chelidonum. Schlotterbeck ("Proc. Amer. Pharm. Asso.," 1900, p. 250) states: "A careful analysis of sanguinaria shows that instead of getting a

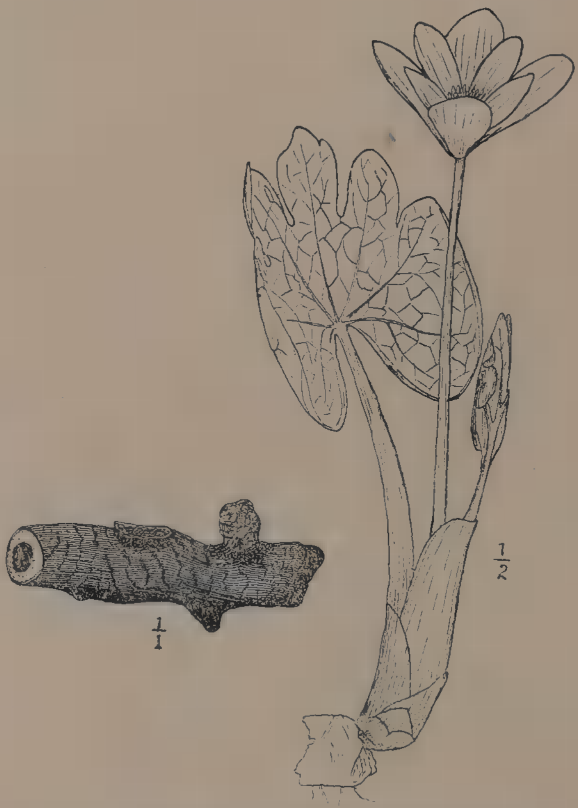

FIG. 28.—*Sanguinaria canadensis*—Plant and rhizome.

large percentage of sanguinarine, as the rhizome should yield, scarcely 1 per cent. was obtained." He believes that "the name Sanguinarine should be applied to the predominating alkaloid, to the one that forms yellow salts. Sanguinarine nitrate is becoming recognized more and more by the medical profession as a remedy in respiratory disorders and throat troubles."

Preparation of Sanguinarine.—Treat infusion of the powdered rhizome with dilute HCl or acetic acid, add NH_4OH, collect precipitate, redissolve in alcohol, decolorize, and evaporate. It is white, soluble in alcohol, ether, benzene; yields bright red salts of an acrid taste.

ACTION AND USES.—An acrid emetic, stimulant, narcotic. It is also expectorant, used in chronic bronchitis and in advanced stages of the acute disease. Dose: Expectorant, 0.2 Gm. (3 gr.); emetic, 1 Gm. (15 gr.).

OFFICIAL PREPARATIONS.

Fluidextractum Sanguinariæ, ...Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.).
Tinctura Sanguinariæ (10 per cent.), .. 15 to 30 ♏ (1 to 2 Cc.).

40. **RHŒAS.**—RED POPPY. The petals of **Papa'ver rhœ'as** Linné, the red or corn poppy of our gardens, growing abundantly as a wild plant in Europe. Nearly round, 50 mm. (2 in.) broad, contracted below into a short blackish claw; when fresh, they are of a scarlet-red color, but become brownish-purple on drying, and have an opium-like odor and a somewhat bitter

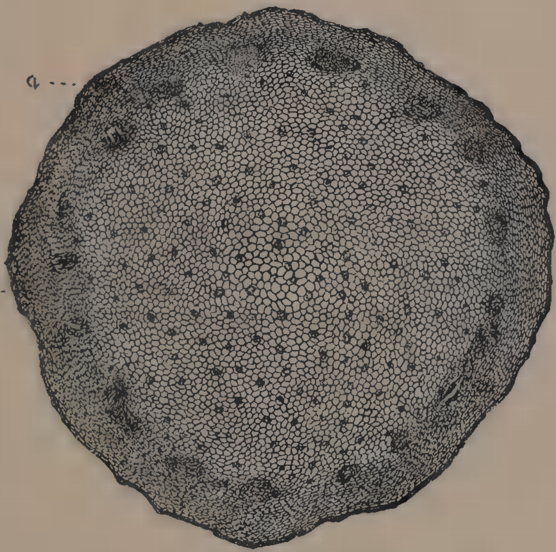

FIG. 29.—Sanguinaria. *a*. Wood-bundle. *b*. Pith.

taste. All parts of the plant contain the alkaloid rhœadine, which produces interesting reactions with acid and alkalies. It does not appear to be poisonous. Acid solutions produce a purple color, which disappears when neutralized. One part of the alkaloid produces a deep purple with 10,000 parts of water, rose with 20,000, and a perceptible redness with 800,000 parts. According to Hesse, the milky juice also contains meconic acid. Red poppy is a weak and uncertain opiate; **used in pharmacy almost wholly in the fresh state for coloring preparations.**

FUMARIACEÆ.—Fumitory Family.

Erect or climbing herbs with alternate leaves. Slightly bitter, innocent plants. Bocconia cordata (= Macleya cordata), Tree Celandine, belongs to this order (see Chelidonium). Yields protopine.

41. **CORYDALIS.**—TURKEY CORN. Tubers of **Dicen'tra canaden'sis** De Candolle. *Habitat:* Canada and the mountains of the United States south to Kentucky. Small, heavy, **pebble-like tubers,** often united, three

around a common center; of a dull yellowish to a dull black color, semi-translucent; inodorous; bitter. They contain four alkaloids, the chief of which is corydaline ($C_{18}H_{19}NO_4$), four-sided prisms, inodorous, tasteless, insoluble in water, soluble in ether, alcohol, and chloroform. This interesting alkaloid has been found in other species of corydalis, as *C. cava*.

Preparation of Corydaline.—Treat the residue from evaporated tincture with dilute HCl. Precipitate with ammonia and dissolve precipitate in boiling alcohol; on evaporation of this solution four-sided prisms of the alkaloid are deposited.

CRUCIFERÆ.—Mustard Family.

Herbs with pungent, watery juice; *sepals* and *petals* 4 each, cruciform; *stamens* 6, tetradynamous; *capsule* usually spuriously 2-celled; *fruit* a silique or silicle.

Synopsis of Drugs from the Cruciferæ.

A. *Seeds.*	B. *Herb.*	C. *Root.*
SINAPIS ALBA, 42.	Bursa Pastoris, 44.	Armoracia, 45.
SINAPIS NIGRA, 43.		

42. SINAPIS ALBA.

WHITE MUSTARD. *Ger.* WEISSER SENF.

The seed of **Sina'pis al'ba** Linné.

Botanical Characteristics.—Stem 1 to 2 feet high, round, smooth. *Leaves* lyrate-pinnatifid. *Flowers* yellow. *Silique* hispid. *Seeds* whitish, with the *embryo* folded upon the surface of one of the cotyledons, which is also folded so as to inclose it.

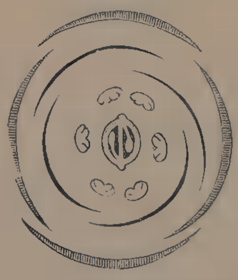

Fig. 30.—Diagram of a flower of the *Cruciferæ*.

Fig. 31.—The embryo of *Brassica pumias orientalis*.

Habitat.—Asia and Southern Europe; cultivated.

Description of Drug.—The principal difference between this and black mustard is that of color and size, being 1 to 2 mm. in diam., of a yellowish color, and less pungent. **The oily embryo consists of a curved caudicle and two cotyledons, one folded over the other.** Both the black and white seeds are practically free from starch. Commercial ground mustard is an unctuous yellowish

powder which cakes on pressure; it is usually a mixture of the ground white mustard (dull yellow) and the black mustard (yellowish-green). The mixture is, however, often rendered brighter by the addition of turmeric; when this is the case, it will respond to the test for starch, and will acquire a red-brown color with a solution of borax or boric acid. The "limit of starch" test of the U. S. P., page 394, will betray dilution with starchy substances. Moistened with water the powder quickly develops a pungent odor.

Powder.—Light yellowish-brown. Characteristic elements: Starch, sometimes in small amounts; epidermal cells large, thin, with mucilaginous walls; endosperm cells, thin-walled, with fat and proteid; sclerenchyma consisting of stone cells from inner layer of seed coat.

CONSTITUENTS OF BLACK AND WHITE MUSTARD.—Both contain a fixed oil, 22 to 23 per cent.; mucilage about 19 per cent. Both seeds contain the ferment myrosin, the white having usually the larger quantity. The quantity of myrosin in these seeds is quite variable, sometimes being as low as 2 per cent., then as high as 18 per cent. A glucoside exists in the white mustard, *sinalbin* ($C_{30}H_{44}N_2S_2O_{16}$), which, decomposed by myrosin, yields glucose, sinapine sulphate, and a fixed oil, which is the *sulphocyanate of acrinyl*, and is found to be identical with *para oxyphenylacetic acid*. H. Salkowski manufactured this principle synthetically. The black mustard contains *sinigrin* ($C_{10}H_{18}KNS_2O_{10}$), which yields, when decomposed by the ferment myrosin, glucose, potassium sulphate, and a volatile oil, *allyl isothiocyanate* ($CS : N.C_3H_5$), the common mustard oil.

Preparation of Sinalbin.—Extract powdered white mustard with benzene (CH) to remove oil. Treat the dried dregs with four times its weight of boiling alcohol. Filter the alcoholic liquid while hot. On standing in a cool place the liquid deposits crystals of sinalbin.

Preparation of Sinigrin.—Oil is removed, as in the case of sinalbin. The oil cake is then boiled in alcohol and evaporated to dryness. Repowder and extract with cold water. Treat the resulting liquid with barium carbonate and evaporate on a waterbath to dryness. Extract the residue with strong boiling alcohol and filter while hot. On cooling and standing the solution deposits silky needles of sinigrin, or potassium myronate.

ACTION AND USES.—Same as Sinapis Nigra. Average dose: 2 dr. (8 Gm.).

43. SINAPIS NIGRA.

BLACK MUSTARD. *Ger.* SCHWARZER SENF.

The ripe seed of **Bras'sica ni'gra** Linné.

BOTANICAL CHARACTERISTICS.—Similar to *S. alba* (see above), but has larger flowers, a longer hispid silique, and a smaller blackish seed.

HABITAT.—Asia and Southern Europe; cultivated.

DESCRIPTION OF DRUG.—A globular seed about 1 mm. ($\frac{1}{25}$ in.) in diameter, with a circular hilum and a short beak not filled with albumen; **testa hard,** black, or reddish-brown, **finely pitted.** The yellow embryo and cotyledons are folded and bent along the midrib. Inodorous when dry, but **pungent and penetrating when moist;** taste hot, acrid. (For limit of starch, see U. S. P., page 394.)

Powder.—Reddish-brown. Characteristic elements: Similar to white mustard; collenchymatous cells wanting; stone cells smaller than white mustard; endosperm yellow with KOH. The same reagent to white mustard gives orange color.

FIG. 32.—*Sinapis nigra*—Branch.

ACTION AND USES.—Externally a **powerful rubefacient and counter-irritant,** internally **emetic,** especially valuable in cases of poisoning by narcotics from its reflex stimulation of the heart and respiration. Dose: 1 to 4 dr. (4 to 15 Gm.).

OFFICIAL PREPARATIONS.

Charta Sinapis.
Oleum Sinapis Volatile. (Used in counter-irritant liniments.) Extremely pungent and volatile.

43 a. **OLEUM SINAPIS EXPRESSUM** (Unofficial).—Crushed seeds of the black and white mustard yield, by cold expression, about 22 per cent. of a bright yellow (white) or brownish-yellow (black) oil, of a bland taste. This oil is a commercial oil and not infrequently used for the adulteration of other oils. Rapeseed, or colza, oil is obtained from the seeds of different varieties of the genus Brassica, rape (*Brassica napus*) in particular. In Europe the term rapeseed oil is sometimes applied to the product of rape alone, colza being restricted to the oil obtained from the ruta-baga, or Swedish turnip (*B. campestris*), while "Rubsen" oil is furnished by the common turnip (*B. rapa*). There is great confusion among authors in the use both of the common names of the oils and the scientific names of the varieties of Brassica which produce them. The seeds of rape contain from 33 to 43 per cent. of oil, which, when crude, is a dark yellow-brown and used for lubricating. Refined and freed from albumen and mucilage the oil becomes bright yellow. Rape oil is extensively used for lamps, lubricating machinery, and for adulterating both almond and olive oils.

44. **BURSA PASTO'RIS.**—Shepherd's Purse. The herb of **Capsel'la bursa-pastoris** Moench, a small plant very common along our roadsides. It derives its name from its inversely heart-shaped fruit in elongated racemes. The small white flowers are in corymbose racemes. Nearly inodorous; taste acrid, pungent, and bitter. Contains a little volatile oil of mustard. An active diuretic, also tonic and stimulant. Dose: 15 to 60 gr. (1 to 4 Gm.).

45. **ARMORACIA.**—Horseradish. The root of **Cochlea'ria armora'cia** Linné. Indigenous to Europe, but cultivated in our gardens as a condiment. A cylindrical root 300 mm. (12 in.) long, 12 to 25 mm. (½ to 1 in.) thick; externally pale yellowish-brown, warty; internally white; fracture short; odor when crushed pungent; taste sharp and acrid. Contains a volatile oil similar to oil of mustard. Used only in fresh state as a stimulant to digestion, as a diuretic, and externally as a rubefacient. Dose: 1 to 2 dr. (4 to 8 Gm.).

CISTINEÆ.—Rock-rose Family.

46. **HELIANTHEMUM.**—Frostwort. The herb of **Helian'themum canaden'se** Michaux. *Habitat:* North America. As found in commerce it consists of broken branches or stems not longer than 1 to 1½ inches, mixed with a few broken roots, crushed, woolly leaves, and, occasionally, yellow petals; the stems are red-brown, thread-like, slightly pubescent, internally whitish, with a very large pith; taste astringent and bitter. It contains a bitter glucoside (?), soluble in water, alcohol, and benzol, and 11 per cent. of tannin, with sugar and gum. Tonic, astringent, and alterative, in the treatment of scrofulous diseases. Dose: 5 to 20 gr. (0.3 to 1.3 Gm.).

VIOLARIEÆ.—Violet Family.

Herbs with alternate or radical leaves; *corolla* of 5 unequal petals, one being spurred; *stamens* 5, connivent, alternate with the petals; *fruit* a 3-valved capsule.

47. **VIOLA TRICOLOR.**—Pansy. Heart's-Ease. The herb of **Viola tricolor** Linné. *Habitat:* Europe, North America, and Northern Asia; cultivated. The drug consists of the herbaceous upper portion of the plant, including green leaves, straw-colored, broken stems, and the variegated flowers. Odor slight, pleasant; taste somewhat bitter. It contains salicylic acid 1 per cent., sugar, mucilage, a bitter principle, resin, and violin (in small quantity). Mucilaginous, emollient; much used in Europe as an alterative in skin diseases, especially eczema. Dose: ½ to 2 dr. (2 to 8 Gm.).

CANELLACEÆ.

An order furnishing mostly aromatic trees.

48. **CANELLA.**—Canella. The bark of **Canel'la al'ba** Murray. A native of Florida, West Indies, etc. In quills or broken pieces deprived of the corky layer; outer surface orange-red, marked with small scars and depressions; inner surface whitish; odor slight, **aromatic; taste bitter and very pungent and biting.** It contains a reddish volatile oil (about 2 per cent.), a portion of which is closely related to eugenol of oil of cloves, with resin, ash, mannite, a bitter principle, cellulose, albumen, and starch. Aromatic and stimulant, used as an adjuvant. The powder is used in making "hiera picra," Pulv. aloes et canellæ, N. F (formerly official).

49. **CINNAMODENDRON.**—The bark of **Cinnamoden'dron cortico'sum** Miers. An aromatic bark from Jamaica, coming in curved or quilled pieces. Odor cinnamon-like; taste bitter, biting, giving a suggestion of canella, but this bark contains tannin, which canella does not. Used as an aromatic stimulant. Enters commerce solely from the Bahamas, where it is known as cinnamon bark, or as white wood bark.

BIXINEÆ.

Trees and shrubs with alternate simple leaves and regular, symmetrical flowers. The fruits of some species are edible, and gums are obtained from a few others.

50. **GYNOCARDIA.**—CHAULMOO'GRA. The seed of **Gynocar'dia odora'ta** R. Brown. *Habitat:* Malayan Peninsula. Contains an acrid, whitish fat, known in market as **chaulmoogra oil,** separated from the kernels by expression or by boiling water, then taken up by ether or chloroform, which, when evaporated, leaves the oil almost pure. Gynocardic acid, a constituent, is sometimes employed in medicine. "The oil is a very successful remedy in eczema of the third stage." The oil is esteemed in India for the treatment of all manner of skin diseases. Its unctuous smoothness has been compared to that of goose-grease. Dose (of oil): 10 to 20 ♏ (0.6 to 1.3 Cc.), in gelatin capsules or in emulsion.

51. **ANNATO.**—A coloring substance obtained from a tropical American tree, **Bix'a orella'na.** The seeds steeped in water and allowed to ferment, and this liquid evaporated to a paste, becomes the **anna'to of commerce, used as a cheese and butter color.** By the natives the fragrant reddish pulp of the seeds is used as an astringent in diarrhea. It is also used as a dyestuff for silks and other fabrics.

POLYGALEÆ.—Milkwort Family.

Plants often with milky juice in roots, low herbs in temperate regions, with *leaves* mostly simple, entire, dotted, exstipulate. *Flowers* irregular; *sepals* 5, the two inner large, petaloid; *petals* 3, the anterior one larger. Properties: generally bitter (polygala), acrid (senega), or astringent (krameria).

Synopsis of Drugs from the Polygaleæ.

A. *Roots.*
KRAMERIA, 52.
SENEGA, 53.

B. *Herb.*
Polygala, 54.

52. KRAMERIA.—KRAMERIA.

RHATANY. *Ger.* RATANHAWURZEL.

The dried root of **Krame'ria trian'dra** Ruiz et Pavon, and of **Krame'ria ixi'na** Linné and other undetermined species of Krameria. (Fam. Krameriaceæ—U. S P. 1900.)

BOTANICAL CHARACTERISTICS.—A low, woody shrub, with grayish leaves and red flowers. The *flowers* are solitary in the axils of the upper leaves, short-stalked. The *fruit* is globular, leathery, indehiscent, about the size of a pea, and covered with reddish-brown, hooked prickles.

SOURCE.—*Krameria triandra* (Red rhatany) is a native of Peru, the commercial supply being obtained from the southern provinces; abundant about the cities of Huanucco and Lima; shipped from Paytu. *Krameria ixina* (Sawanilla or New Granada rhatany) is yielded by several varieties, as *K. tomentosa*, St. Hil., an extremely woolly form growing in Colombia, British Guiana, and Northern Brazil;

FIG. 33.—*Krameria triandra*—Flowering branch.

shipped from Carthagena, Santa Marta, etc. Para rhatany, described by Berg, is said to be from *K. argentea;* grayish-brown color.

DESCRIPTION OF DRUG.—From 10 to 30 mm. ($\frac{2}{5}$ to $1\frac{1}{5}$ in.) thick, knotty, and with several thick heads above, and branches below, from which emanate cylindrical roots about 6 to 12 mm. ($\frac{1}{4}$ to $\frac{1}{2}$ in.) thick and from 100 to 400 mm. (4 to 16 in.) long. In commerce the more **woody**

pieces, with short stumpy branches, constitute the largest proportion; the bark is tough and fibrous, **dark reddish-brown,** scaly, rugged, and about 1 to 2 mm. ($\frac{1}{25}$ to $\frac{1}{12}$ in.) thick; the wood is hard and compact, light reddish-brown in color, and when cut with a knife, presents a shining surface, marked with concentric circles and fine medullary rays. Inodorous; taste **very astringent,** the bark more so than the wood. *Krameria ixina* (Savanilla rhatany) is more slender and less knotty, dull purplish-brown, with smooth, closely adhering bark. To distinguish the powders resulting from the Peruvian and Savanilla roots, shake with water and reduced iron, filter, and dilute with distilled water. Peruvian powder will give a dingy brown, and the Savanilla a vislaceous, color. Lead acetate with alcoholic tinctures produces, with Peruvian, red-brown; with Savanilla and Para, a bluish-gray or purple color and colorless filtrate. Para rhatany, like Savanilla, becomes bluish-black when immersed in solution of ferrous sulphate. Peruvian variety becomes a dark green. This root is peculiarly elastic.

FIG. 34.—*Krameria triandra*—Cross-section of root. (18 diam.) A, Cork. B, Thin-walled parenchyma of cortex. C, Xylem. D, Medullary ray. (Photomicrograph.)

Powder.—Deep red. Characteristic elements: Parenchyma cells of cortex with reddish-brown coloring-matter; starch grains, 20 to 30 μ in diam., 1 to 4 compound; calcium oxalate in prisms and pyramids; sclerenchyma with few short, thick-walled bast fibers. In Savanilla variety the sclerenchymatous fibers, the parenchyma, bast, and ducts, are larger.

CONSTITUENTS.—**Kramero-tannic acid** (20 per cent.), rhatanin, and rhatanic-red (a coloring matter). The tannic acid in a state of purity is perfectly colorless, but accompanying it is phlobaphene, an extractive which gives its solutions a reddish-brown color. Gives a dark green precipitate with ferric salts, a flesh-colored precipitate, with gelatin, and none with tartar emetic. **Extracts of krameria should be made with cold water,** the solution being evaporated

at a low temperature. Boiling water extracts apotheme, the presence of which is a detriment to the astringent principle.

ACTION AND USES.—A powerful astringent, with some tonic properties. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Krameriæ (20 per cent.), ... Dose:	½ to 2 fl. dr. (2 to 8 Cc.)
Fluidextractum Krameriæ, ...	5 to 30 ♏ (0.3 to 2 Cc.).
Syrupus Krameriæ (45 per cent. of fl'ext.), ...	2 to 6 fl. dr. (8 to 24 Cc.).
Extractum Krameriæ, ...	5 to 10 gr. (0.3 to 0.6 Gm.).
Trochisci Krameriæ (about 1 gr. of ext. in each troche), ...	1 or 2 troches.

53. SENEGA.—SENEGA.

SENEKA. SENEGA SNAKEROOT. *Ger.* SENEGAWURZEL.

The dried root of **Polyg'ala sen'ega** Linné.

BOTANICAL CHARACTERISTICS.—*Stems* several, from a thick and hard, knotty root-stock; *leaves* lanceolate, with rough margins; *calyx* with 3 *sepals*, small, greenish, and 2 larger (called wings), colored; *flowers* white, in a solitary, close spike.

SOURCE.—Almost all parts of the United States east of the Rocky Mountains. It is collected for market in Kentucky and in the states west and southwest of it, and in Wisconsin, and in immense quantities in northern Minnesota. This latter variety is known as northern senega. It is, as a rule, a larger root than the southern; the anatomical and structural differences between the two roots are probably very slight. *Polygala alba*, Nutt., inhabits Western Texas and Western Kansas, but this variety of senega is not systematically collected for the market as are the roots of Minnesota and Kentucky.

DESCRIPTION OF DRUG.—A contorted root, about 100 mm. (4 in.) long, with a **knotty crown bearing numerous remnants of scaly leaves.** The main root is from 5 to 10 mm. ($\frac{1}{5}$ to $\frac{2}{5}$ in.) thick, fleshy, but void of starch. It varies in color from a light yellow to a dark brown externally; much-branched, the branches spreading, tortuous, longitudinally wrinkled, annulate near upper end; **bark thickish,** inclosing a porous, yellowish wood, but easily separable from it; it consists of three layers, the inner one excessively **developed on one side, forming a prominent cord or keel on drying,** fracture short when dry. Odor faint, sometimes wintergreen-like; taste sweetish, afterward acrid and nauseating. The liquid preparations of it have a characteristic nauseous odor.

Powder.—Yellowish-brown. Characteristic elements: Parenchyma cells 25 to 40 μ in diam.; many collenchymatous cells, with phloëm distributed through-

out; stone cells few; ducts 10 to 30 μ in diam., with simple and bordered pits; wood fibers short, porous; cork yellow 20 to 30 μ in diam.

Constituents.—The acrid principles to which its medicinal action is entirely due, are **polygalic acid,** $C_{19}H_{30}O_{10}$, and **senegin,** $C_{17}H_{26}O_{10}$—two homologues. The distinction between polygalic acid and senegin

Fig. 35.—*Polygala senega*—Plant and rhizome.

is mainly one of solubility in alcohol (the former more soluble). Lead acetate precipitates polygalic acid, but does not precipitate senegin. The root also contains a fixed oil, and a small quantity of volatile oil, which is a mixture of valerianic ether and methyl salicylate, resin, malic acid, and sugar. Liquid preparations of senega are apt to become

gelatinous, which is ascribed to the presence of pectin compounds; but is very likely, at least in part, due to sapogenin, generated under the influence of acids or other compounds; the jelly is rendered soluble again on the addition of an alkali. The above proximate principles are similar to the saponins.

ACTION AND USES.—A valuable stimulating expectorant, for which it is generally used; also diuretic, and in large doses emetic and cathartic. It affects the heart like digitalis. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

FIG. 36.—Senega—Cross-section of Root. (21 diam.) A, Xylem. B, Parenchyma of cortex. C, Cork (Photomicrograph.)

OFFICIAL PREPARATIONS.

Fluidextractum Senegæ, ... Dose:	10 to 30 ♏ (0.6 to 2 Cc.).
Syrupus Senegæ (20 per cent. of fl'ext.), .	30 to 60 ♏ (2 to 4 Cc.).
Syrupus Scillæ Compositus (Fl'ext. senega 8 per cent., Fl'ext. squill 8 per cent., Tartar emetic, 0.2 per cent.)....	10 to 60 ♏ (0.6 to 4 Cc.).

54. **POLYGALA RUBELLA** Willdenow.—BITTER POLYGALA. A North American herb, used for its tonic properties. The bitter principle is easily extracted by water and alcohol.

FRANKENIACEÆ.

55. **FRANKENIA.**—YERB'A REUM'A. (Herb.) A California plant, **Frank-en'ia grandiflo'ra** Chamisso et Schlechtendal. A valuable topical application in catarrhal affections, and in diseases of the mucous membranes generally. Dose of fluidextract: 10 to 30 ♏ (0.6 to 2 Cc.), diluted.

CARYOPHYLLEÆ.—Pink Family.

Herbs with swollen joints, opposite, entire, and regular flowers; *petals* 4 or 5 mostly removed from the calyx by a short internode. Usually bland herbs; some are highly valued as ornamental plants.

56. **SAPONARIA LEVANTICA.**—Levant Soapwort. The root of **Gyp'-sophila panicula'ta** Linné. *Habitat:* Italy to Asia Minor. A simple, fusiform root, longitudinally wrinkled, and marked with transverse ridges; used in washing silks and other fabrics. It contains sapotoxin (8.5 per cent.), and the acrid glucoside saponin, yielding by hydrolysis sapogenin, which is used as a detergent.

57. **SAPONARIA.**—Soapwort. **Sapona'ria officina'lis** Linné. An acrid root, found in Europe and the United States; contains resin, and the glucoside, saponin. The latter is a white powder, soluble in hot water and alcohol; its solution when shaken foams like soap-water. When treated with acids it is split into sugar and a crystallizable principle, sapogenin, soluble in water. Used as an alterative in doses of 15 to 60 gr. (1 to 4 Gm.).

58. **STELLARIA.**—Chickweed. The herb of **Stella'ria me'dia** Smith. Demulcent and emollient; a poultice is used in ophthalmia, bruises, inflammation, etc.

PORTULACEÆ.—Purslane Family.

59. **PORTULACA.**—Garden Purslane. The herb of **Portula'ca olera'cea** Linné. Refrigerant and mild efficient diuretic in ascites; it has a beneficial action in catarrhal affections of the genito-urinary tract. Dose: 1 to 3 dr. (4 to 12 Gm.).

HYPERICINEÆ.—St. John's-wort Family.

60. **HYPERICUM.**—St. John's-wort. The herb of **Hype'ricum perfora'tum** Linné. *Habitat:* Europe, Asia, and North America. The drug as it appears in market is composed of a mixture of oblong-ovate, pellucid-punctate leaves, thread-like branches, and less slender, brittle stems, with occasionally black-dotted flower petals, the whole having a greenish-brown appearance. Constituents: Resin, tannin, and a red coloring matter. Used as a stimulant, diuretic, and astringent. Dose: 30 to 60 gr. (2 to 4 Gm.).

GUTTIFERÆ.

Trees or shrubs with opposite or whorled coriaceous leaves; *stamens* indefinite; *stigmas* sessile, radiant. Many species, like the gamboge, yield a yellow juice; the *seeds* of others are oily. Among the edible *fruits* of the order is the mangosteen, regarded as the most delicious fruit in the world.

61. CAMBOGIA.—Gamboge.

GAMBOGE. *Ger.* GUMMIGUTT.

A gum-resin from **Garcin'ia hanbu'rii** Hooker filius.

Botanical Characteristics.—The gamboge tree has diœcious flowers and a foliage resembling that of laurel. *Flowers* yellow; *male flowers* in axillary

clusters, on short, one-flowered pedicels. *Female flowers* sessile. *Fruit* a berry, about the size of a large cherry, reddish-brown, containing a sweet pulp

HABITAT.—Anam, Camboja, Siam, and Cochin-China.

DESCRIPTION OF DRUG.—**Lumps,** or **cylindrical sticks** (pipes), 25 to 50 mm. (1 to 2 in.) in diameter, and 100 to 200 mm. (4 to 8 in.)

FIG. 37.—*Garcinia hanburii*—Branch.

in length, striated lengthwise by impressions from the bamboo in which it is collected. Externally, grayish-brown. It has a smooth, conchoidal fracture of **a waxy luster and orange-red in color.** The powder is bright yellow and sometimes adheres to the drug, giving it a yellow appearance. Taste at first mild, afterward very acrid; odor irritating, sternutatory. The cake or lump gamboge is sold in

masses weighing two or three pounds. It is less uniform, less brittle, and is sometimes called "coarse gamboge." Adulterated specimens are easily recognized by their general inferior appearance, by the grayish or bronze appearance of a broken surface, and by giving a blue or green color with iodine when starch is one of the impurities. Pure gamboge is completely soluble by successive treatment with ether or alcohol and then water.

CONSTITUENTS.—A bright yellow **resin** (gambogic acid) 73 per cent., soluble in alcohol and ether, turned to a red color by alkalies, and black-brown by ferric chloride; **gum** 16 to 26 per cent., which, with the resin and hot water, forms a yellow emulsion; wax 4 per cent. and ash 1 per cent.

ACTION AND USES.—A drastic **hydragogue cathartic,** but so liable to produce vomiting and griping that its action is usually modified by combining it with other milder purgatives. Dose: ½ to 5 gr. (0.0324 to 0.3 Gm.), generally in pill form.

OFFICIAL PREPARATION.

Pilulæ Catharticæ Compositæ (about 0.015 Gm. of gamboge in each pill), ...Dose: 2 to 5 pills.

62. **MANGOSTANA.**—MANGO FRUIT. MANGOSTEEN. The pericarp of the fruit of **Garcin'ia mangosta'na** Linné, of India. Astringent; used in various diseases of the mucous membrane, in injections, etc. Mangostin has been isolated from the pericarp. It is golden-yellow in color, crystallizes in scales, soluble in alcohol and ether. The fruit yields a fatty oil, concrete oil of mangosteen, called kokum butter, used in soap-making. It is well adapted for pharmaceutical preparations and candle-making. Dose: 15 to 60 gr. (1 to 4 Gm.).

TERNSTRŒMIACEÆ.—Tea or Camellia Family.

Trees or shrubs with simple, usually alternate, leaves, often fascicled at the tops of the branches.

63. **THEA.**—TEA. The leaves of **Camel'lia the'a** Link. *Habitat:* Southern Asia; cultivated. From 25 to 75 mm. (1 to 3 in.) long, petiolate, acute at both ends, irregularly serrate except at base, and with anastomosing veins near the margin; bluish-green or blackish. The green color of tea is not infrequently intensified by a mixture of Prussian-blue and gypsum. Odor peculiar, taste bitter and astringent. Contains volatile oil and an alkaloid, theine, which is analogous to, if not identical with, caffeine. Astringent, tonic, stimulant, and nervine; one of the most valuable stimulating and restorative agents.

DIPTEROCARPEÆ.

Trees often gigantic, exuding a resinous juice; rarely shrubs.

64. **GURJUN.**—GURJUN BALSAM. WOOD-OIL. An oleoresin exuding from **Dipterocar'pus turbina'tus** Gaertner, and other species of Dipterocarpus. *Habitat:* India and the East Indies. **A thick, viscid balsam with uses**

and properties similar to copaiba. Opaque, and grayish, greenish or brownish in reflected light; transparent and reddish-brown or brown in transmitted light; odor copaiba-like; taste bitter. It contains a volatile oil, 40 to 70 per cent., which is similar to oil of copaiba in composition, and produces a red or violet color with a drop of H_2SO_4 and HNO_3 mixed; also gurjunic acid (crystalline), resin, and a bitter principle. Owing to its close resemblance to copaiba it has been used in considerable quantities for the purpose of adulterating the latter. The United States Pharmacopœia gives one of the many excellent tests for detecting its presence in this official oleoresin.

65. **BORNEO CAMPHOR.**—Sumatra Camphor and Borneol. A stearopten, or camphor, $C_{10}H_{18}O$, obtained in solid crystalline form from fissures and cavities in a gigantic forest tree, **Dryoba'lanops aroma'tica** Colebrook, growing in the Malay Archipelago. It occurs in masses some pounds in weight. Differs from the ordinary camphor in having a higher specific gravity (heavier than water) and in being less volatile. With nitric acid it yields the Japan (laurel) camphor, $C_{10}H_{16}O$

MALVACEÆ.—Mallow Family.

Mucilaginous, innocent plants, with tough bark and palmately-veined *leaves; stamens* monadelphous, in a column, and united with the short claws of the petals; *pistils* several, the ovaries united in a ring, or forming a several-celled pod.

Fig. 38.—Vertical section of Mallow flower.

Synopsis of Drugs from the Malvaceæ.

A. *Root.*
ALTHÆA, 66.

B *Flowers.*
Althæa Rosea, 67.
Malva, 68.

C. DERIVATIVES OF THE COTTON PLANT.

Bark, 69 a. Filamentous Hairs, 69 b. Oil, 69 c.

66. ALTHÆA.—Althæa.

MARSHMALLOW. *Ger.* EIBISCHWURZEL.

The dried root of **Althæ'a officina'lis** Linné, collected from plants of the second year's growth and deprived of periderm.

Botanical Characteristics.—Stem 2 to 4 feet high. *Leaves* ovate, or slightly heart-shaped, toothed, downy. *Flowers* pale rose color.

Habitat.—Europe, Asia, United States, and Australia.

Description of Drug.—Whitish, cylindrical, or conical pieces deprived of the outer corky layer, from 75 to 150 mm. (3 to 6 in.) long, and about 10 mm. ($\frac{2}{5}$ in.) or more in diameter; longitudinally wrinkled, and marked with numerous brownish scars; **somewhat hairy externally from loosened bast fibers;** it breaks with a short mealy fracture, with projecting fiber-ends near the outer edge; odor faint, but

characteristic, stronger in infusion; taste sweetish and **mucilaginous.** A cross-section shows small wood-bundles of scalariform and pitted vessels scattered throughout the prevailing parenchymatous tissue, but with an indistinctly radiate arrangement near the edge. The cells of the **parenchyma contain starch** and mucilage, with a few stellate rhaphides.

Powder.—Light yellow. Characteristic elements: Parenchyma with starch 5 to 15 μ in diam.; calcium oxalate 10 to 35 μ in diam. with mucilage cells and rosette masses of asparagin; bast fibers of sclerenchyma 10 to 20 μ thick; ducts scalariform and reticulate.

CONSTITUENTS.—**Asparagin,** $C_4H_8N_2O_3H_2O$, 1 per cent. (a colorless, nearly tasteless, crystalline principle), **bassorin,** $C_{12}H_{20}O_{10}$, 25 per cent. (althæa mucilage, a turbid, slimy, non-adhesive mucilage, which when dried forms a very coherent mass), sugar 8 per cent., **pectin** 10 per cent., ash 5 per cent., starch 35 per cent., a fixed oil, and a trace of tannin.

ACTION AND USES.—Used as a demulcent application to inflamed mucous tissues, as in bronchitis. Powdered marshmallow root being exceedingly absorbent,

FIG. 39.—*Althæa officinalis*—Flowering branch.

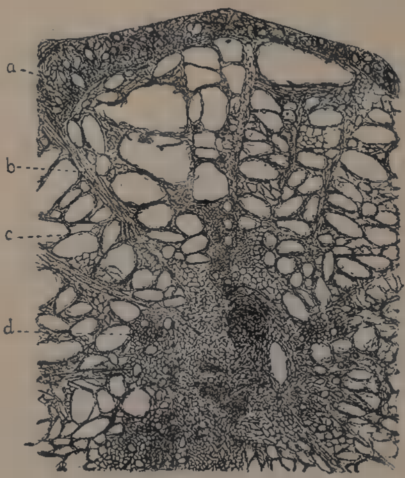

FIG. 40.—Cross-section of a portion of the trimmed branch of Althæa. *a.* Bark. *b.* Medullary ray. *c.* Parenchyma. *d.* Wood-bundle. Magnified 18 diam.

is used advantageously to impart consistency to soft pill-masses. (In Mass. Hydrarg., 15 per cent. In Blaud's Pills and Pil. Phosphorus.)

67. **ALTHÆ'A RO'SEA** Cevanilles.—HOLLYHOCK. (Petals.) Indigenous to Western Asia, but cultivated in gardens for its large, purple, ornamental flowers. Petals broadly obovate, notched above and with a claw at base; odor slight; taste sweetish, mucilaginous, and astringent. They contain tannin, mucilage, and a coloring matter. An infusion is occasionally used as a demulcent.

68. **MALVA.**—MALLOW. The flowers of **Mal'va sylves'tris** Linné, an herbaceous plant growing abundantly in Europe. When fresh, of a rose-red or purple color, becoming blue when dried; odor slight; taste sweetish and mucilaginous. Emollient and demulcent.

69. DERIVATIVES OF THE COTTON PLANT.—ALL OFFICIAL.

Bark, Hairs of Seed, and the Oil of **Gossyp'ium herba'ceum** Linné, and other species of Gossypium.

BOTANICAL CHARACTERISTICS OF GOSSYPIUM HERBACEUM.—Large herbs with alternate *leaves*, which are more or less palmately-lobed. *Flowers* are large, showy, more or less yellow or red; *pistils* 5, united at their base. *Stamens* numerous, united below and adhering to the petals. *Capsule* roundish, 3- to 5-celled, opening at the top by as many valves. The numerous *seeds* are glossy, covered with long, woolly hairs, which constitute the cotton.

HABITAT.—Asia and Africa; cultivated in the United States.

69 a. **ROOT BARK.—Gossypii Cortex.** COTTON-ROOT BARK.—Long bands or curved pieces, sometimes in quills. The outer surface is of a yellowish-brown color, dotted with a few small black spots, and, from the abrasion of the thin cork, numbers of orange-brown patches; the inner surface is whitish and has a silky luster; **the bast fibers are long and tough, and may easily be separated into papery layers;** inodorous; taste very slightly acrid and astringent.

Powder.—Light brown. The microscopical elements are: The simple and compound starch grains, the aggregate calcium oxalate crystals, colored resin, and tannin masses; the numerous long, slender, and thick-walled bast fibers (8 to 15 μ thick), large cork cells, etc.

CONSTITUENTS.—A yellow resin, fixed oil, tannin (small quantity), sugar, starch, and, in the fresh bark, a yellow chromogen, which becomes red and resinous on exposure to the air. To this change is due the red color of old specimens, and old preparations, of the bark.

ACTION AND USES.—Emmenagogue and oxytocic, stimulating uterine contractions probably by direct action on the uterine center in the spinal cord; said to be as efficient and more safe than ergot. Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Gossypii Radicis (1890),..Dose: ½ to 1 fl. dr. (2 to 4 Cc.).

69 **b. HAIRS OF SEED.—Gossypium Purificatum.** PURIFIED COTTON. Fine, white, soft filaments, which, under the microscope, appear as hollow, flattened, and twisted bands; unacted upon

FIG. 41.—*Gossypium herbaceum*—Branch.

by ordinary solvents. Ordinary raw cotton contains among other impurities fatty substances, which, when removed by chemical means, such as alkaline or ethereal solvents, changes its character so that the fiber, which formerly was almost impenetrable by aqueous liquids, now becomes so absorbent that it no longer floats on water, but when placed on the surface of that liquid will readily absorb it and sink.

CONSTITUENTS.—Almost pure cellulose; by the action of nitric acid this is converted into soluble gun-cotton.

ACTION AND USES.—Employed as a dressing for burns, scalds, and excoriated surfaces, and for making antiseptic cottons, such as salicylated cotton, benzoinated cotton, iodoform cotton, etc.

OFFICIAL PREPARATION.

Pyroxylinum (Soluble Gun-cotton), the basis of the various official collodions.

69 **c. OIL.**—OLEUM GOSSYPII SEMINIS. A fixed oil expressed from the seeds. Pale yellowish, odorless, with a bland, nut-like taste; specific gravity 0.920 to 0.930 at 15° C. (59° F.), solidifying at about 0° to −5° C. (32° to 23° F.); very sparingly soluble in alcohol. Brought into contact with concentrated sulphuric acid, the oil at once assumes a dark reddish-brown color. Color reactions with nitric acid and silver nitrate (see U. S. P. tests) distinguish this oil from other similar oils. The oil is used as a basis for Linimentum Ammoniæ, Linimentum Camphoræ, etc. Processes have been invented for purifying the crude oil to abstract its acrid resin, and so leave it bland and as palatable as the olive oil, for which it is oftentimes substituted as a table or salad oil.

CONSTITUENTS.—Palmitin, olein, and a pale-yellow coloring-matter that is non-saponifiable.

STERCULIACEÆ.

Trees or shrubs with soft wood; sometimes climbing. *Fruit* dry, rarely fleshy (Theobroma, 71); *seeds* globose or ovoid, with coriaceous or crustaceous testa. The two plants of interest of the order are the one mentioned and Cola, 70.

70. **COLA.**—COLA (KOLA). The dried kernel of the seed of **Cola acuminata** R. Brown (Fam. *Sterculiaceæ*), yielding by assay 1 per cent. of total alkaloids. Occurring in irregular somewhat plano-convex pieces; cotyledons from 15 to 30 mm. long and 5 to 10 mm. thick; dark brown or reddish-brown; fracture short, tough; odor faintly aromatic, taste astringent and somewhat aromatic. The drug contains alkaloids consisting mostly of **caffeine and theobromine,** about 40 per cent. of starch, a little volatile oil, fat, and tannin. The *kolanin* of Knebel is simply a kolatannate of caffeine. Kolatannic acid differs from caffeotannic acid in being free from sugar. Tonic, stimulant, and nervine; used as a beverage by the natives of Africa as is coca by the natives of South America. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

"Bissey nuts" are the seed of the Cola naturalized and cultivated in the West Indies. An article upon the subject may be found in the "American Druggist," 1894, page 356. It should be said with regard to the many preparations of Cola that they seem to lack a certain degree of permanence: the fluidextract of the Cola, for example, is an unsatisfactory preparation, because

of the immense precipitation which goes on for a long time after the preparation is made.

71. **THEOBROMA.**—CACAO. CHOCOLATE NUT. The seed of **Theobro'ma caca'o** Linné. *Habitat:* Mexico; cultivated in the West Indies. About the size of an almond, flattened, invested with a thin, longitudinally wrinkled testa, varying from reddish to grayish-brown in color; somewhat ovate in shape, the hilum being situated on the broader end. The cotyledons are brown, oily, somewhat ridged. Odor agreeable when bruised; taste bitterish, oily. Contains 45 to 53 per cent. of fixed oil (Cacao Butter), and 1.5 per cent. of theobromine, an alkaloid similar to caffeine. **Chocolate** is made by roasting the seed, removing the testa, then powdering the kernels, forming the powder into cakes with water, and flavoring with vanilla or other substances.

FIG. 42.—Cola (Kola Nut). Showing longitudinal section of fruit × ⅕; cross-section of red seed × ⅓; longitudinal section of red seed showing embryo × ⅓; cross-section of red seed × ⅓; longitudinal section of white seed. (*After Kohler.*)

Preparation of Theobromine.—Obtained from an infusion of cacao, precipitating it with lead acetate, removing excess of lead by H_2S, evaporating, and exhausting the residue with boiling alcohol. The alkaloid separates on cooling. Sparingly soluble in cold water, alcohol, and ether.

71 a. **OLEUM THEOBROMATIS, U. S.**—CACAO BUTTER. A fixed oil expressed from the seed. A yellowish-white, brittle, fatty solid, of tallow-like consistence, melting at 30° to 33° C. (86° to 91.4° F.), about the temperature of the body; has a faint, chocolate-like taste and agreeable odor. Should respond to the various important official tests (see U. S. P.). Contains palmitin, stearin, laurin, olein (small quantity), theobromine, and glycerides of formic, acetic, and butyric acids. Employed largely in making suppositories.

TILIACEÆ.—Linden Family.

Mostly tropical trees, some of the species of the genus Tilia, yielding tenacious fibers for cordage. Flowers balsamic, furnishing infusions which are antispasmodic and diaphoretic.

FIG. 43.—*Theobroma cacao*—Branch and fruit.

72. **TILIA AMERICANA** Linné.—LINDEN FLOWERS. BASSWOOD LIME TREE. *Habitat:* North America Flowers yellowish; petals notched at base; odor pleasant; taste sweet and mucilaginous. Stimulant, diaphoretic, and lenitive. Dose: 15 to 30 gr. (1 to 2 Gm.) The bark is used as a demulcent, emollient, and vulnerary.

LINACEÆ.—Flax Family.

Stems herbaceous; annual or perennial, rarely woody plants closely allied to the mallows, remarkable, however, in having the inner fiber of the bark very tenacious, and for the mucilaginous covering of the seed, in which there is an abundance of drying fixed oil. A few are bitter.

73. LINUM.—LINSEED.

FLAXSEED. *Ger.* FLACHSSAMEN.

The ripe seed of **Li'num usitatis'simum** Linné.

BOTANICAL CHARACTERISTICS.—The common flax is an annual; stem corymbosely branched at top. *Leaves* sessile, linear-lanceolate, smooth. *Flowers* in a corymbose *panicle*, with sky-blue petals. *Pod* about the size

FIG. 44.—*Linum usitatissimum.*

of a pea, of 5 united carpels (into which it splits in dehiscence), and 5-celled, with two seeds hanging from the summit of each cell, which is partly or completely divided into two by a false partition projecting from the back of the carpel, the pod thus becoming 10-celled.

Habitat.—All temperate countries.

Description of Drug.—**Oblong-ovate, flat,** obliquely pointed at one end and blunt at the other. The brown, glossy, polished surface is seen, under the lens, to be marked with fine pits, and to be covered with a transparent **mucilaginous epithelium** that swells in water. The hilum occupies the slight hollow just below the apex. The embryo is oily, whitish, and inodorous. Taste mucilaginous, oily, and slightly bitter. Flaxseed meal is of a brownish-gray color, and has a slight odor.

Powder.—Brown. Characteristic elements: Parenchyma of endosperm, thin-walled, with aleurone and oil globules; testa with parenchyma of deep brown tabular cells; sclerencyhma of small yellow stone cells; epidermal cells, prismatic and mucilaginous; starch, when present, spherical.

Constituents.—A viscid yellow fixed oil, 30 to 35 per cent., proteids 25 per cent., resin, wax, a small quantity of amygdalin, and from 3 to

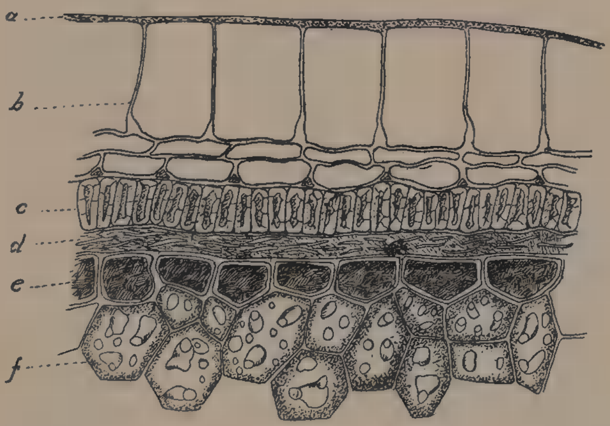

Fig. 45.—Cross-section of Flaxseed. *a.* Epithelium. *b.* Epidermal cells in swollen condition. *c.* Stone cells. *d.* Layer of collapsed cells for building stone cells. *e.* Pigment coat. *f.* Containing oil.

4 per cent. of ash. An althæa-like mucilaginous substance resides in the epithelial layer, which swells considerably in water. This gummy matter from the investing coat is rapidly imparted to hot water, forming a thick, viscid mucilage, precipitated by alcohol and lead subacetate. The gummy principle is considered as transformed starch, which latter exists in the immature seed, but is absent in the ripe seed.

73 a. **OLEUM LINI, U. S.**—A **yellowish fixed oil expressed** (for medicinal use) **from the seed without heat,** having a slight, pleasant odor, and a bland taste; on exposure to the air it gradually thickens and acquires a strong odor and taste. The oil used in the arts is obtained on a large scale by roasting the seeds before being pressed, in order to destroy the gummy constituents of the coating. It does

not congeal above –20° C. (–4° F.), and should respond to the various official tests (see U. S. P.). The most characteristic principle in the oil is **linolein,** $C_{12}H_{28}O_2$, a glyceride of linoleic acid, and considered to be a mixture of two acids—linolic, $C_{18}H_{32}O_2$, and linolenic acid, $C_{18}H_{30}O_2$. The drying property of the oil resides in this constituent.

ACTION AND USES.—The whole seed is used in decoction as a demulcent; ground flaxseed is a favorite farina for poultices; the expressed oil is laxative, and, in combination with lime-water (Linimentum Calcis), is much employed as a protective in burns, etc.

OFFICIAL PREPARATION.

From Oleum Lini.
Linimentum Calcis (equal parts of linseed-oil and lime-water).

74. COCA.—COCA.

ERYTHROXYLON. *Ger.* COCABLÄTTER.

The dried leaves of **Erythrox'ylon Co'ca** Lamarack (Fam. Erythroxyllaceæ, U. S. P. 1900), known commonly as **Huanuco** (Bolivian) **Coca,** or of **E. Truxillense** Rusby, known commercially as **Truxillo** (Peruvian) **Coca,** yielding, when assayed by U. S. P. process, not less than 0.5 per cent. of ether-soluble alkaloids of coca

BOTANICAL CHARACTERISTICS.—Shrub about six feet high, with bright green leaves, size and shape similar to those of tea, and white blossoms, which are succeeded by small scarlet berries. When the leaves mature, the branches are stripped and the leafless plant is soon again covered with verdant foliage. The plant is propagated in nurseries from the seed.

SOURCE.—The shrub bearing coca leaves is extensively cultivated on the slopes of the Andes about 2000 to 5000 feet above the sea level, in **Peru and Bolivia.** The province of La Paz in Bolivia produces about the largest crops. That of Bolivia is considered superior to the Peruvian, although the latter country produces double the quantity. In this latter country, especially owing to the European demand, the cultivation has considerably increased. The annual production reaches the enormous figures of about one hundred million pounds. Two varieties, "Truxillo" and "Huanuco," having different characteristics, come to this market, the former named after the port Trujillo in the northern part of Peru, and the latter from the city of Huanuco, in the central part of Peru. The culture of coca leaves has been tried in other countries, but with questionable results, except, perhaps, on the Island of Java. The plant yields its first crop when eighteen months old, and continues to bear about forty years. There are two pickings yearly—April and September; the latter is considered the best and most abundant. The leaves are

laid out in a paved drying yard and afterward pressed in drums (tambors) of plantain leaves, the tambor weighing forty pounds net.

DESCRIPTION OF DRUG.—*Huanuco Coca.*—Greenish-brown to clear brown, smooth and slightly glossy, thickish and slightly coriaceous, stoutly and very short petioled; blade 2.5 to 7.5 cm. long and nearly elliptical, with a very short and abruptly narrowed basal portion and a short point, the margin entire; midrib traversed above by a slight ridge, very prominent underneath, the remaining venation obscure,

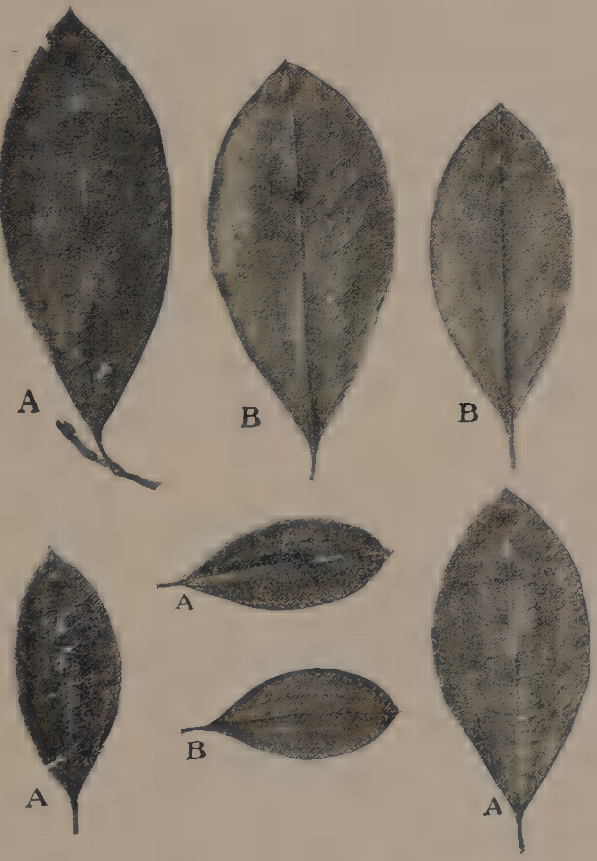

FIG. 46.—Coca Leaves—A, Upper side. B, Under side. (Photograph. Natural Size.)

especially above; underneath, two conspicuous lines of collenchyma tissue run longitudinally on either side of the midrib and about one-third of the distance between it and the margin, the enclosed areola being of a slightly different color from the adjacent surface; odor characteristic; taste bitterish, faintly aromatic, followed by a numbness of the tongue, lips, and fauces.

Truxillo Coca.—Pale green, thin, brittle and usually much broken, smooth but not shining, shortly and stoutly petioled; blade 1.6 to

5 cm. long and one-third to one-half as broad, obovate to oblanceolate, narrowed from near the middle into the petiole, usually with a slight projecting point at the summit, the margin entire; underneath two irregular lines of collenchyma tissue, usually incomplete or obscure, and frequently wanting, run beside the midrib; odor more tea-like than that of Huanuco Coca;* taste and numbing effect similar.

Powder.—Greenish. Characteristic elements: Calcium oxalate of parenchyma in prisms, 3 to 10 μ in diam.; sclerenchyma, bast, and crystal fibers; small papillæ on under epidermal cells.

CONSTITUENTS.—A volatile liquid alkaloid (?), **hygrine,** and **cocaine** ($C_{17}H_{21}NO_4$), which has been found to be a compound body represented in a methyl benzoyl compound of another organic base, **ecgonine** ($C_9H_{16}NO_3$). There are also present in the leaves **benzoyl ecgonine, a methyl compound of which constitutes the alkaloid cocaine.** This complex body cocaine is readily decomposed into its component parts, methyl alcohol, benzoic acid, and ecgonine, by heating with HCl. Hydrochloric acid is, therefore, unsuitable for the extraction of cocaine in the process of its manufacture. The percentage of cocaine varies greatly, hence it is important to assay the leaves and its preparations. U. S. P. process of assay shows 0.5 per cent. of ether-soluble alkaloids of the leaf.

Preparation of Cocaine.—Exhaust the powdered drug by repercolation with water acidulated with 5 per cent. H_2SO_4. Agitate the concentrated liquid with pure coal oil and an excess of Na_2CO_3. The oily liquid is then shaken with acidulated water and again precipitated by Na_2CO_3 in the presence of ether. From the ethereal solution the alkaloid can be obtained on evaporation.

ACTION AND USES.—**Stimulant** to digestion, the brain, and respiration. **Checks the process of wasting,** enabling the laborer to endure a greater amount of physical exertion with a small amount of food. For this purpose the leaves are habitually chewed by the natives. Dose: 15 to 60 gr. (1 to 4 Gm.). Cocaine is a valuable local anæsthetic. Applied to mucous surfaces and injected subcutaneously. Dose: ½ to 1 gr. (0.0324 to 0.064 Gm.).

Solutions of the alkaloid in olive and castor oil are stable. Cocaine ointments should not be made with lard or vaseline, as it is insoluble in these fats. If the hydrochlorate be dissolved in a little water before admixture, a stable ointment is effected.

OFFICIAL PREPARATION.

Vinum Cocæ (6.5 per cent. Fl'ext.), ...Dose: 4 fl. dr. (16 Cc.).
Fluidextractum Cocæ, ... 1 to 4 fl. dr. (4 to 15 Cc.).

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* For an exhaustive description of coca leaves, see article by Dr. H. H. Rusby. "Drug. Circ.," Nov., 1900, p. 220.

ZYGOPHYLLACEÆ.

The wood of many species of this order is remarkable for its excessive hardness. The two official drugs from the order are the wood, 75, and resin, 76, of guaiacum.

75. **GUAIACI LIGNUM.**—Lignum Vitæ. The heart-wood **of Gua'iacum officina'le** and **G. sanctum** Linné. Greenish-brown, resinous raspings or chips, mixed with yellowish particles of the sap-wood; odor slight, agreeable, increased by heating or rubbing; taste slightly aromatic, but irritating and persistent after chewing some time. The heart-wood of guaiac is im-

Fig. 47.—*Guaiacum sanctum*—Flowering branch.

ported in billets or logs and used for turning out various instruments and utensils, the shavings from these being used in pharmacy. The **sap-wood** is yellowish, the **heart-wood** dark greenish-brown, hard and heavy, remarkable in that its specific gravity is such as to sink in water. *Constituents:* **The resin** (soluble in alcohol and alkaline fluids) **is the most important constituent,** of which it contains about 26 per cent.; it also contains 0.8 per cent. of bitter, pungent extractive. The wood or chips are turned a bluish-green by the action of nitric acid fumes.

Stimulant, diaphoretic; also a reputed antirheumatic and antisyphilitic. Generally given in the form of compound decoction of sarsaparilla. Dose: 15 to 60 gr. (1 to 4 Gm.).

76. GUAIACUM.—GUAIAC.

GUM GUAIAC. *Ger.* GUAJAKHARZ.

The resin from the wood of **Gua'iacum officina'le** Linné and of **G. sanctum.**

SOURCE.—Obtained from natural exudation or from incisions into the trunk, occasionally by boring longitudinally through a billet, placing one end in the fire, and catching the melted resin as it exudes from the hole in the other end; more commonly, however, by extracting the chips or raspings with a boiling solution of common salt.

DESCRIPTION OF DRUG.—**Greenish-brown, irregular masses,** containing fragments of wood and bark; brittle, breaking with a glossy

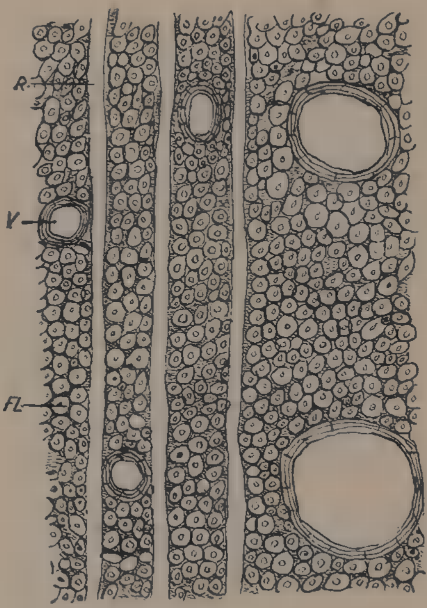

FIG. 48.—*Guaiacum*—Cross-section of wood. *R.* Medullary rays, composed of one, two, and three ranges of cells *V.* Closed vessels. *Fl.* Ligneous fibers, very much developed and forming concentric zones.

fracture; in thin pieces, transparent. The powder is gray when fresh, but **becomes green on exposure,** and blue when in contact with oxidizing agents. Odor slight, balsamic, when heated resembling benzoin; taste slightly irritating.

CONSTITUENTS.—**Guaiacic acid,** β-resin (11.75 per cent.), and guaiac yellow, $C_{20}H_{20}O_7$, soluble in milk of lime; guaiaretic acid, $C_{20}H_{24}O_4$, 11.15 per cent.; **guaiaconic acid,** 50 per cent., and gum and ash in small quantity. Guaiacene, guaiacol, cresol, and pyroguaiacin are obtained by dry distillation. The coloring matter crystallizes in pale yellow or quadratic octahedra having a bitter taste.

The so-called "guaiacum oil" is obtained by boiling guaiacum resin with solution of sodium carbonate, allowing to cool, filtering, saturating the filtrate with carbon dioxide, again filtering, extracting the oil with ether, and allowing the solvent to evaporate. The product is soluble in water, alcohol, and ether. From the alkaline liquid acids precipitate the yellow coloring matter ("guaiacum yellow"), which imparts a blue color to strong sulphuric acid.

The blue color which guaiacum resin produces with certain oxidizing agents is due to an oxidation product of guaiaconic acid.

Action and Uses.—Stimulant, diaphoretic, and alterative; also a mild purgative. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

Official Preparations.

Tinctura Guaiaci (20 per cent.), ...Dose: 30 to 60 ♏ (2 to 4 Cc.).
Tinctura Guaiaci Ammoniata (20 per cent.), ... 30 to 60 ♏ (2 to 4 Cc.).

GERANIACEÆ.—Geranium Family.

Herbs with opposite or alternate leaves, usually stipulate, simple or compound. *Flowers* regular or irregular; *carpels* prolonged above into beaks terminated by the styles, which give rise to the name Cranesbill, applied to the principal genus.

77. GERANIUM.—Geranium.

CRANESBILL. *Ger.* FLECKSTORCHSCHNABEL-WURZEL.

The dried rhizome of **Gera'nium macula'tum** Linné.

Botanical Characteristics.—*Stem* erect, hairy; *leaves* about 5-parted; *flowers* light purple; *petals* entire, bearded on the claw

Habitat.—North America.

Description of Drug.—**Rough, knotty, cylindrical, horizontal, rhizome,** 50 to 75 mm. (2 to 3 in.) long, and 10 mm. ($\frac{2}{5}$ in.) thick; longitudinally wrinkled, tuberculated, very hard, and sometimes beset with shriveled, brittle rootlets; externally dark brown; fracture short, reddish-gray, showing a thin bark, several small, yellowish wood-wedges forming a circle near the cambium line, and a large pith; medullary rays broad. The rootlets have a thick bark and a thin central column of fibrovascular tissue. Inodorous; taste astringent.

Powder.—Grayish-brown. Characteristic elements: Large aggregate crystals of calcium oxalate; ducts porous and reticulate; parenchyma with crystals and starch. (Highly magnified starch grains, see Fig. 374.)

CONSTITUENTS.—Tannic (12 to 37 per cent.) and gallic acids, with resin, starch, gum, pectin, and a red coloring matter. Both alcohol and water extract its virtues.

ACTION AND USES.—A valuable and pleasant astringent. It has been claimed that the rhizome contains mucilaginous material which, acting as a demulcent, makes a decoction a much more desirable prepa-

FIG. 49.—*Geranium maculatum*—Flowering branch.

ration than a simple solution of tannin. The fluidextract is said to be useful in buccal ulcer, etc. Dose: 15 to 30 gr. (1 to 2 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Geranii, ...Dose: 20 to 60 ♏ (1.3 to 4 Cc.).

78. **IMPATIENS PALLIDA.**—JEWEL WEED. Indigenous herb occasionally used as an alterative and diuretic in infusion. Dose: 1 dr. (4 Gm.). *Impa'tiens balsam'ina*, the touch-me-not of the gardens, has the same properties.

RUTACEÆ.—Rue Family.

To facilitate study, this order has been divided, one of the subdivisions being the suborder Aurantieæ (see below). The rueworts are remarkable for yielding acrid and resinous principles and volatile oil. *Ruta montana*, growing in Spain, is so extremely acrid that it raises pustules on the skin of those who gather it. The peduncles and flower of the European Dittany are so laden with volatile oil that the plant ignites at the approach of a lighted candle.

Synopsis of Drugs from the Rutaceæ.

A. *Barks.*	B. *Leaves.*	C. *Fruits.*
XANTHOXYLUM, 79.	**BUCHU,** 83.	Bela, 86.
Angustura, 81.	**PILOCARPUS,** 84.	Xanthoxyli Fructus, 80.
Ptelia Trifoliata, 82.	Ruta, 85.	

(Products of the suborder Aurantieæ, p. 150.)

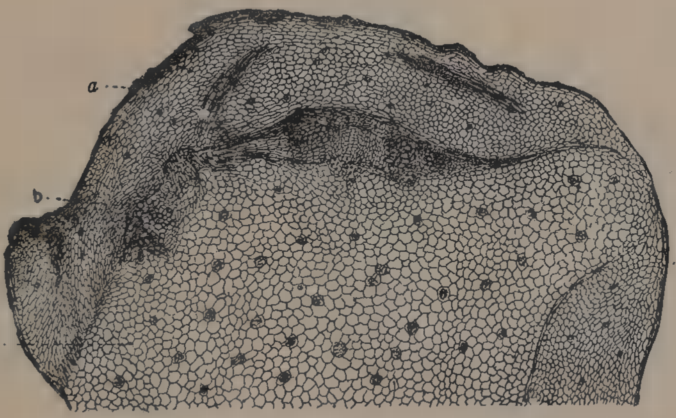

FIG. 50.—Cross-section of Cranesbill. *a.* Bark. *b.* Wood-wedge. *c.* Pith. (12 diam.)

79. XANTHOXYLUM.—XANTHOXYLUM.

PRICKLY-ASH BARK. *Ger.* ZAHNWEHHOLZ.

The bark of **Xanthox'ylum america'num** Miller, and of **Fagara clava-her'culis** Linné, known in commerce respectively as Northern Prickly-ash and Southern Prickly-ash.

BOTANICAL CHARACTERISTICS.—The northern prickly-ash, *X. americanum*, bears its *leaves* and *flowers* in sessile, axillary, umbellate clusters; *leaflets* 2 to 4 pairs, and an odd one, obovate-oblong, downy when young. The southern prickly-ash, *F. clava-herculis*, bears its *flowers* in an ample terminal cyme, appearing after the leaves; *leaflets* 3 to 8 pairs, and an odd one, ovate or ovate-lanceolate, oblique, shining above.

HABITAT.—United States.

DESCRIPTION OF DRUG.—Northern prickly-ash (*X. americanum*), as found in commerce, is in curved or quilled pieces about 1 mm. ($\frac{1}{25}$ in.) thick; the outer surface is of a brownish-gray color, longitudin-

ally furrowed and **showing a few yellowish-gray patches of foliaceous lichens, also numerous black dots** and a few straight spines. Inner surface is light brown or yellowish; fracture uneven, short; inodorous; taste bitter, pungent, and acrid. Southern prickly-ash (*F. clava-herculis*) is somewhat thicker and has conical corky projections, with a few spines rising from corky bases. Inner surface free from acicular crystals.

Powder.—Light brown. Characteristic elements: Parenchyma of inner cortex with abundant calcium oxalate, in prisms, and aggregate, 10 to 25 μ in diam.; large resin-bearing cells; sclerenchyma consisting of yellowish stone cells, and bent bast fibers.

CONSTITUENTS.—An acrid green oil, a colorless crystalline resin, sugar, ash 11 to 12 per cent., tannin (small quantity), and a bitter principle which is turned brown by H_2SO_4.

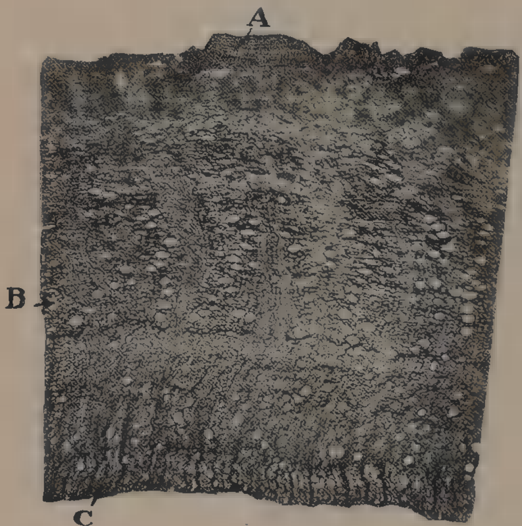

FIG. 51.—Xanthoxylum—Cross-section of bark. (15 diam.) A, Cork. B, Resin cells. C, Medullary ray. (Photomicrograph.)

ACTION AND USES.—Alterative, sialagogue, stimulant, and tonic, its action being similar to that of guaiac and mezereum. The bark chewed is a popular remedy for toothache, giving rise to the synonym, toothache-tree. The fluid extract is frequently combined with such alteratives as stillingia, lappa, etc. The berries are used in compound syrup of stillingia (see National Formulary). Dose: 15 to 45 gr. (1 to 3 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Xanthoxyli,..............Dose: 30 to 60 ♏ (2 to 4 Cc.).

80. **XANTHOXYLI FRUCTUS.**—PRICKLY-ASH FRUIT. Consists of brownish-red capsules about 4 to 5 mm. ($\frac{1}{5}$ to $\frac{1}{4}$ in.) in diameter, sessile on the thin receptacle (*X. clava-herculis*), or borne on short stalks (*X. americanum*); the two valves open when ripe and expose the one or two shining, more or less wrinkled, black seeds; odor aromatic; taste very pungent and somewhat bitter. Stimulant, tonic, and alterative; used in fluid extract of stillingia, N. F. Dose: 15 to 30 gr. (1 to 2 Gm.).

81. **ANGUSTURA.**—CUSPARIA BARK. The bark of **Galipe'a cuspa'ri** St. Hilaire. *Habitat:* Northern South America. Found in the market in flattish, quilled, or channeled pieces about 3 mm. ($\frac{1}{8}$ in.) thick, and not longer than 150 mm. (6 in.), but usually shorter; externally it is covered with a yellowish-gray, corky layer, which is marked by shallow longitudinal fissures, and

in most cases easily removed by the nail; inner surface light cinnamon-brown, often with adhering strips of wood; internally reddish-brown, showing white points due to deposits of calcium oxalate. **The tissue of the bark is loaded with oil cells.** Odor musty, due to volatile oil; taste bitter and nauseous. Besides volatile oil and resin, the bark contains a bitter principle, **angusturin, and four alkaloids,** the most important of which is **cusparine.** Used as an aromatic bitter. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

82. **PTELIA TRIFOLIATA** Linné.—WATER ASH. Shrub growing in the United States east of the Mississippi. (Root-bark.) It contains berberine. Used as a tonic and antiperiodic, "its mild, non-irritating properties rendering it especially valuable in low fevers attended with gastro-intestinal irritation; this soothing influence causes it to be retained when other tonics would be rejected." Dose of fluid extract: 15 to 30 ♍ (1 to 2 Cc.).

FIG. 52.—*Barosma betulina*—Branch and flower.

FIG. 53.—*Barosma crenulata*—Flowering branch.

83. BUCHU.—BUCHU.

SHORT BUCHU. *Ger.* BUKUBLÄTTER.

The dried leaves of **Baros'ma betuli'na** (Thunberg) Bartling et Wendland.

BOTANICAL CHARACTERISTICS.—Shrubby plant. The characteristics common to the buchus are opposite *leaves*, small, simple, coriaceous, dotted with

pellucid glands. *Flowers* pink (*betulina*), white (*crenulata*), solitary on axillary or terminal peduncles. *Fruit* composed of five follicles, adherent at the axis and dehiscing at the summit.

HABITAT.—Southern Africa, Cape of Good Hope.

DESCRIPTION OF DRUG.—About 15 mm. long, varying between oval and obovate, yellowish-green, apex obtuse, margin crenate or serrate with a gland at the base of each tooth, base more or less wedge-shaped; coriaceous, both surfaces beset with numerous slight projections; odor strong and characteristic; taste somewhat mint-like, pungent and bitterish. *B. serratifolia* (very narrow, linear-lanceolate) constitute the "long buchu" of commerce. The long buchu (off. in U. S. P. 1890) contains less of the volatile oil. Transverse sections

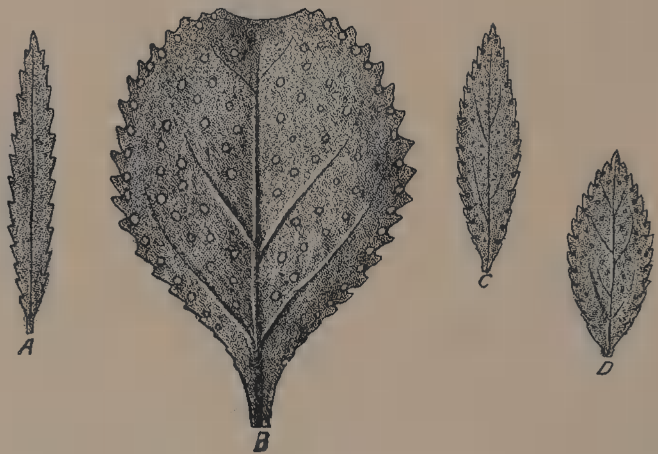

FIG. 54.—Buchu Leaves and Adulterant. *A*, Leaf of *Empleurum serrulatum*. *B*, Leaf of *Barosma betulina* (enlarged). *C*, Leaf of *Barosma seratifolia*. *D*, Leaf of *Barosma crenulata*.

show a subcuticular layer of thickened cells, rich in mucilage, and containing sphæro-crystals. Both kinds usually require careful garbling, as they are often mixed with branchlets, fragments of capsules, and with leaves of allied species. The long buchu is sometimes mixed with the leaves of *Empleurum serrulatum*, but these are still narrower, often longer, and terminate in an acute point, without an oil duct.

Powder.—Pale green. Characteristic elements: Epidermal cells with vertical walls straight; sphæro-crystals of inulin, 30 to 50 μ in diam.; few short, one-celled trichomes; numerous oil globules; few tracheids with simple pores; few long bast fibers; crystals of calcium oxalate 15 to 25 μ in diam.

CONSTITUENTS.—**Volatile oil** is contained in large circular cells just beneath the epidermis of the under surface of the leaf; the short buchu yields the greater per cent. (1 to 1.56 per cent.). On exposure to

cold it separates out barosma camphor, which existed in the oil dissolved in a hydrocarbon. The upper surface of the leaves swells up in water, due to a layer of mucilage cells just beneath the surface. The bitter principle is **rutin**; **resin** is also present.

ACTION AND USES.—A mild diuretic in disorders of the urinogenital organs, its action depending upon the volatile oil. In Cape Colony the leaves are employed as a stimulant and stomachic. Dose: 15 to 45 gr. (1 to 3 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Buchu,..............Dose: 15 to 60 ♍ (1 to 4 Cc.).

84. PILOCARPUS.—PILOCARPUS.

JABORANDI. *Ger.* FOLIA JABORANDI.

The leaflets of **Pilocar'pus jaboran'di** Holmes or of **Pilocarpus microphyllus** Stapf. Yielding when assayed by U. S. P. process not less than 0.5 per cent. of alkaloids.

BOTANICAL CHARACTERISTICS.—A shrub 4 to 5 feet high. *Leaflets* 1 to 4 pairs, petiolate. *Flowers* in long racemes. *Ovary* with 5 carpels. *Seeds* black, angular.

SOURCE, VARIETIES, AND ADULTERATIONS.—The name Jaborandi is a generic one, applied in South America to several plants possessing diaphoretic properties. The shrub, *Pilocarpus jaborandi*, grows in Brazil in the neighborhood of Pernambuco. E. M. Holmes determined the origin of the leaf in 1875. Several varieties of the genus, regarded by some as distinct species, grow in its native country. The *P. selloanus* (Rio Janeiro jaborandi) differs in some few particulars from the Pernambuco; the latter, for example, has elliptical, oblong-shaped leaflets, of more fleshy consistence, the veinlets being more prominent on the upper surface, etc.

E. M. Holmes ("Pharmac'l Journal and Transactions," fourth series, 501) describes a new kind of jaborandi met with in the English market (probably *P. spicatus*), which differs in several particulars from the Pernambuco drug. As compared with the true jaborandi, the leaves differ wholly from the official leaf, having a more shining surface, but very little difference in the color of the two surfaces. The same author ("Pharmac. Journal," fourth series, vol. 3, p. 2) calls attention to a spurious leaf in importations of *P. microphyllus* (which yields a larger percentage of alkaloid), differing from this in absence of oil from their tissues, by their reticulated venation, etc. These are probably derived from some hitherto undescribed variety.

It has been adulterated with species of Piper, which are not pellucid-punctate, with *Laurus nobilis*, etc.

DESCRIPTION OF DRUG.—Leaves nearly sessile, pinnate, with a terminal leaflet; the leaflets, which come into market separate, are **ovate-oblong, entire,** about 100 mm. (4 in.) long, and 50 mm. (2 in.) broad; short-petiolate; uneven at the base; **slightly revolute at**

FIG. 55.—*Pilocarpus selloanus*—Branch from flowering top.—(*After Kohler.*)

margin, near which **the anastomosing veins form one or two distinct wavy lines; coriaceous;** dull green, finely marked with small, transparent dots or oil-cells, plainly visible when held up to the light; texture coriaceous, brittle; when bruised a peculiar, rather unpleasant odor is emitted; this odor is predominant in the fluid extract. Taste disagreeable, slightly pungent, and bitter. The leaflets of *P. microphyllus* (Maranham jaborandi) are smaller (2.5 to 4 Cm.

in length), usually ovate in outline, deeply emarginate at apex. **Alkaloidal content (chiefly Pilocarpine) of best leaf ranges from 0.5 to 1 per cent.**

Powder.—Yellowish-brown. Characteristic elements: Epidermal cells, polygonal; crystals of calcium oxalate, aggregate, 29 to 30 μ in diam., few stone cells and tracheids present; trichomes, non-glandular, one-celled, thick-walled. Requires most careful study to distinguish between powders of different species.

FIG. 56.—Leaf of Jaborandi as it appears in the market.

FIG. 57.—*Ruta graveolens*—Portion of plant.

CONSTITUENTS.—**A volatile oil,** and two alkaloids, **pilocarpine** ($C_{11}H_{17}N_2O_2$), deliquescent, crystalline, inodorous, and slightly bitter, and **jaborine,** chemically isomeric with, but directly antagonistic to, the first named in physiological action. Pilocarpine is the most active, and yields jaborine and pilocarpidine ($C_{10}H_{14}N_2O_2$) when heated with HCl; its salts are readily soluble in water; their action is similar to that of nicotine. **Jaborine** ($C_{22}H_{32}N_4O_4$) **is yellow,** amorphous, and **resembles atropine in action;** its presence in

the commercial pilocarpine explains the different effects following the use of the latter when improperly made. It is therefore very necessary, in using pilocarpine or any of its preparations, to obtain them free from jaborine.

Preparation of Pilocarpine.—To an aqueous solution of acidulated alcoholic extract add alkali and shake with chloroform. From the chloroformic solution the alkaloid is separated by shaking with acidulated (HCl) water, filter, and allow it to crystallize.

ACTION AND USES.—Powerfully diaphoretic and sialagogue by stimulating the nerves supplying the glands and involuntary muscular fiber; cardiac depressant. Dose: 5 to 60 gr. (0.3 to 4 Gm.). Pilocarpine is used as a myotic in ophthalmic practice. It has acquired some reputation in the treatment of diphtheria and croup; frequently administered hypodermically; poisonous. Dose of pilocarpinæ hydrochloras, U. S.: $\frac{1}{8}$ to $\frac{1}{2}$ gr. (0.0081 to 0.0324 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Pilocarpi, ...Dose: 5 to 60 ♍ (0.3 to 4 Cc.).

85. **RUTA.**—RUE. The leaves of **Ru'ta graveo'lens** Linné. *Habitat:* Mediterranean region; cultivated. The whole plant is active, but the leaves are the portion generally employed. They are ternate, the leaflets being obovate-oblong, yellowish-green, thickly dotted with minute, transparent oil-vesicles; odor strong, disagreeable, increased by rubbing; taste bitter, hot, and acrid.

Their medicinal value depends chiefly upon the volatile oil, but there is also present a peculiar coloring matter, rutinic acid, found also in other plants, and an acrid principle, the activity of which is diminished in the dried leaves; the fresh leaves will inflame or even blister the hands if much handled.

ACTION AND USES.—Emmenagogue, vermifuge, and diaphoretic. Dose: 5 to 20 gr. (0.3 to 1.3 Gm.) in infusion. The Romans used rue as a condiment, as the Germans still do.

OLEUM RUTÆ.—A yellowish-green volatile oil, powerfully irritant; used as a uterine stimulant, emmenagogue, etc. Dose: 2 to 5 ♍ (0.13 to 0.3 Cc.).

86. **BELA.**—BAEL FRUIT. BENGAL QUINCE. From **Æ'gle marme'los** Correa. *Habitat:* Himalaya Mountains; cultivated in India, where it is employed and considered as a valuable remedy in dysentery and diarrhœa, relieving without causing constipation. Dose: 1 to 2 dr. (4 to 8 Gm.). It is collected when half ripe and dried; usually enters commerce in segments having a smooth, grayish rind, and a hard, reddish, gummy pulp; whitish internally and divided into cells, each of which contains four or five woolly seeds; taste mucilaginous, slightly bitter; nearly inodorous.

AURANTIEÆ—SUBORDER OF RUTACEÆ.—The Orange Family.

The trees and shrubs which compose this suborder of Rutaceæ are distinguished from others of the order merely by the character of the fruit. In the Aurantieæ the fruit is an indehiscent, juicy, berry-like fruit, botanically known as hesperidium (lemon, orange, and lime), having a leathery rind, containing numerous oil-glands (see Fig. 59). The capsular fruit of the rueworts proper

is usually dehiscent. The leaves and fruit of both suborders abound in minute receptacles of volatile oil. These attain their maximum development in the rind of the orange, lemon, etc.

The Official and Unofficial Products of the Aurantieæ.

I. *The Products of the Orange.*
- A. Official.
  - The Peel, 87.
  - The Oil, 88.
  - Oleum Aurantii Florum, 90 a.
- B. Unofficial.
  - The Leaf, 89.
  - The Flower, 90.

II. *The Products of the Lemon.*
- A. Official.
  - The Juice, 91.
  - The Rind, 92.
  - The Oil, 93.
  - Oil of Bergamot, 94.
- B. Unofficial.
  - White Zapote, 95.

THE ORANGE PRODUCTS.

SOURCE.—Universally cultivated in India and widely in tropical regions. The *sweet orange* was introduced from China by the Portuguese. It has been much improved by cultivation. There are now some fifty varieties in different parts of the globe, these taking the name of the places where cultivated, the sweetest coming from Havana, Florida, and California. *Bitter oranges* were introduced into Europe from India by the Arabians and were used medicinally from very early times, the bitter fruit being usually termed the Seville or Bigarade orange.

(A) OFFICIAL.

87. **AURANTII AMARI CORTEX.**—THE RIND. BITTER ORANGE PEEL, the dried rind of the unripe fruit of *Citrus vulgaris* Risso. **AURANTII DULCIS CORTEX.**—SWEET ORANGE PEEL, the undried outer rind of the ripe fruit of *Citrus Aurantium* Linné. The orange tree is cultivated in the south of Europe, in the Azores, and in the United States—Southern States and California. It is said to be one of great longevity; thus, a tree in Versailles, known as the "Grand Bourbon," planted in 1421, is still in existence (Mueller).

DESCRIPTION OF DRUG.—*Bitter:* In narrow, thin bands or in quarters, epidermis brownish-yellow color, outer layer with numerous oil reservoirs, inner layer spongy, light yellowish-brown; odor fragrant; taste aromatic, bitter. The Curacao orange peel is obtained from a variety of the orange cultivated in the island of Curacao. *Sweet:* Outer surface orange-yellow with numerous oil reservoirs, odor highly fragrant, taste pungently aromatic.

CONSTITUENTS.—Volatile oil (contained in vesicles of the epidermis), hesperidin, ash, and a white principle which turns black with ferric salts.

ACTION AND USES.—Tonic, carminative, and stomachic; a valuable addition to preparations of the bitter tonics like gentian. Dose: 15 to 30 gr. (1 to 2 Gm.).

OFFICIAL PREPARATIONS.

Bitter Orange Peel.	
Fluidextractum Aurantii Amari, ...	Dose: 15 to 60 ♏ (1 to 4 Cc.).
Tinctura Aurantii Amari (20 per cent.).	1 to 2 fl. dr. (4 to 8 Cc.).
Tinctura Cinchonæ Composita (8 per cent.), ...	8.0 Cc. to 2 fl. dr.
Tinctura Gentianæ Composita (4 per cent.)	4.0 Cc to 1 fl. dr.
Sweet Orange Peel.	
Syrupus Aurantii (5 per cent. of Tinct.)	¼ to 1 fl. oz. (8 to 30 Cc.).
Tinctura Aurantii Corticis Recentis (50 per cent.), ...	Flavoring.

FIG. 58.—*Citrus Aurantium*—Branch.

88. **OLEUM AURANTII CORTICIS.**—THE OIL. Obtained from the fresh peel of either the bitter or sweet orange. A pale yellow liquid, having a characteristic aromatic odor. Among the tests for the purity of the oil, the U. S. P. directs that the optical rotation should not be more than 95° to the right in a 100 mm. tube, and at

a temperature of about 25° C. (77° F.). It contains hesperidin, and geranial, an aldehyde.

Oil of Petit-grain is obtained from the small, fragrant, immature oranges (berries about the size of a cherry). Recently, however, the leaves and shoots have been used for this purpose.

Manufacture.—The oils of the fruit of the Aurantieæ are manufactured by subjecting the outer rind to expression, distillation, or, preferably, to the *écuelle* process. This instrument (the écuelle) is described in most works on pharmacy.

FIG. 59.—*Citrus vulgaris*—Flowering branch.

OFFICIAL PREPARATIONS.

Spiritus Aurantii (U. S. P. 1890) (5 per cent.).
Spiritus Aurantii Compositus (contains 25 per cent. oil and the oils of lemon, coriander, and anise).
Elixir Aromaticum (1.2 per cent.).

(B) UNOFFICIAL.

89. **AURANTII FOLIA.**—THE LEAF. From **Cit'rus vulgar'is** Risso. Oval, from 50 to 100 mm. (2 to 4 in.) long, on a broadly-winged petiole, pellucid-punctate; odor aromatic; taste bitter. It is the principal source of *essence de petit-grain*, used to adulterate Oleum Neroli. Stimulant and tonic.

90. **AURANTII FLORES.**—THE FLOWER. ORANGE FLOWERS. The flowers **Cit'rus vulgar'is** and **C. Aurantium,** collected before they are expanded, solely for the volatile oil, which is then most fragrant. Generally used

while fresh, in which state they may be preserved for some time by mixing with half their weight of common salt. They are about 12 mm. ($\frac{1}{2}$ in.) long, with small, cup-shaped calyx and white, rather fleshy petals. Occasionally used as a stimulant and antispasmodic, but principally for preparing orange-flower water and the volatile oil.

OLEUM AURANTII FLORUM, U. S.—OLEUM NEROLI. A thin, yellowish, or brownish-yellow volatile oil, very fragrant. Used as a flavor and as a perfume. Neroli is the predominant odor in Farina Cologne.

THE LEMON PRODUCTS.

91. **LIMONIS SUCCUS—THE JUICE.**—LEMON JUICE. The freshly expressed juice of the ripe fruit of **Cit'rus medica** Linné (**C. limonum** Risso, U. S. P. 1900). A slightly turbid, yellowish liquid

FIG. 60.—*Citrus limonum*—Branch.

having the odor of lemon, due to the presence of some of the volatile oil from the rind; taste acid, often slightly bitter. It contains about 7 per cent. of free citric acid, also phosphoric and malic acids. Refrigerant and antiscorbutic; used in the form of lemonade, or in effervescing draughts. Dose: 1 fl. oz. (30 Cc.).

92. **LIMONIS CORTEX—THE RIND.**—LEMON PEEL. The undried outer rind of the ripe fruit of **Citrus medica** Linné (**C. limonum** Risso, U. S. P. 1900), removed by grating. The fruit comes from the Mediterranean and tropical regions (see Orange). The outer surface is of a light yellow color and ruggedly glandular from the oil-cells; odor fragrant; taste aromatic and bitterish.

Microscopically, the rind of the lemon resembles that of the orange.

CONSTITUENTS.—A pale yellow volatile oil (sp. gr. 0.87) consisting mainly of hydrocarbons, citrene ($C_{10}H_{16}$), cymene ($C_{10}H_{14}$), also citral ($C_{10}H_{16}O$), and a compound ether. Hesperidin ($C_{22}H_{26}O_{12}$), a bitter principle, produces with ferric salts a black color.

Used as a flavoring agent.

OFFICIAL PREPARATIONS.

Spiritus Limonis (U. S. P. 1890) (5 per cent., with oil of lemon 5 per cent.).
Tinctura Limonis Corticis (50 per cent.).

93. **OLEUM LIMONIS.**—OIL OF LEMON PEEL, OR RIND. A volatile oil obtained by expression from the fresh lemon peel. It is a pale yellow, limpid liquid, having a lemon taste and a fragrant odor. It should be protected from light in well-stoppered bottles. Oil of citral, used in perfumery, is obtained from *Cit'rus med'ica* Risso, a large oblong fruit with rough surface—known in England as the citron.

FIG. 61.—Cross-section of Lemon Fruit.

Oil of lemon consists of two isomeric oils (?), chiefly citrene or limonine, $C_{10}H_{16}$, with citral (an aldehyde) and a crystalline product which fuses at 143° to 144° C. (289° to 291° F.), colored yellow by H_2SO_4, and green by HNO_3. Used principally as a flavor.

ADULTERATION OF THE OIL OF LEMON.—It is adulterated with the volatile oil of other fruits of the genus Citrus. These are difficult to detect; odor and taste must be chiefly relied upon.

OFFICIAL PREPARATIONS.

Spiritus Aurantii Compositus (5 per cent.).
Spiritus Limonis (U. S. P. 1890) (5 per cent.).

94. **OLEUM BERGAMOTTÆ.**—OIL OF BERGAMOT. A volatile oil obtained by expression from the rind of the fresh fruit of **Cit'rus berga'mia** Risso et Poiteau, the fruit being collected in November or December, still greenish, unripe, but full grown. By some, the

bergamot orange is supposed to be an established hybrid—a product of cultivation. A greenish or greenish-yellow, thin liquid, having a peculiar, very fragrant odor, and an aromatic, bitter taste. The color is due to chlorophyll. It is distinguished from the oils of orange and lemon by forming a clear solution with solutions of potassium. This oil, so valuable in perfumery, was official in the U. S. P. of 1890, but was dropped from the list in 1900.

CONSTITUENTS.—By fractional distillation there comes over as the first fraction at 60° to 65° about 40 per cent. of the oil. This has a lemon odor and consists of almost pure **limonine.** The second fraction (10 per cent.), distilling at 77° to 82°, consists principally of dipentene, $C_{10}H_{16}$. The third fraction of about 25 per cent., distilling between 87° and 91°, consists of linalool, $C_{10}H_{18}O$. The fourth fraction, 90° to 105° (approximately 20 per cent.), having the pronounced bergamot odor, consists of **linalool (linalyl) acetate,** $C_{10}H_{17}OC_2H_3O$. It is to this that the **peculiar odor of bergamot is probably due.**

95. **WHITE ZAPOTE.**—The seeds of **Casimuroa edulis,** growing in Mexico. Used as a hypnotic in the hospitals of the City of Mexico. Recently introduced in United States. Dose of fl'ext.: 1½ to 9 ♏ (0.1 to 0.6 Cc.).

SIMARUBACEÆ.

Shrubs and trees with scentless foliage; almost confined to the tropics. *Leaves* generally compound and alternate. The bitter bark and wood are employed in medicine.

96. QUASSIA.

QUASSIA. *Ger.* JAMAICA QUASSIAHOLZ.

The wood of **Picrasma excelsa** (Swartz) Planchon, known commercially as **Jamaica Quassia,** or of **Quassia amara** Linné (**Surinam Quassia**).

BOTANICAL CHARACTERISTICS.—A tree resembling the common ash, attaining a height of 50 or 60, or even 100, feet. *Leaves* pinnate, with an odd leaflet; leaflets opposite, 4 to 8 pairs. *Flowers* small, pale yellowish-green, in loose panicles, polygamous. *Fruit* drupaceous, globose, glossy, black.

HABITAT.—Jamaica and other West India islands.

DESCRIPTION OF DRUG.—Imported in dense, **tough billets,** often 300 mm. (12 in.) thick, freed from the thick, tough bark. The yellowish-white or white **raspings or chips** are usually employed in pharmacy. The tissue consists mostly of prosenchyma, associated with long wood-fibers with tapering ends, and ducts which, on transverse sections of the wood, appear as pores; inodorous; taste intensely bitter. Quassia

tonic drinking cups are made from the wood on a turning lathe; water poured into them acquires a bitterness of which the wood seems inexhaustible.

Quas'sia amar'a Linné, Surinam Quassia, comes in much thinner billets, and has a thin, brittle bark; it seldom reaches our market.

FIG. 62.—*Picrasma excelsa*—Branch.

It may be distinguished from the *Picrasma excelsa* (Jamaica quassia) by the fact that the medullary rays in the former consist of single rows of cells, while those of the latter consist of three rows each. The cells composing the rays in the *Q. amara* are of equal size, and their radial walls appear wavy in tangential section; whereas the corresponding cells in *P. excelsa* are of variable size and exhibit regu-

lar walls in tangential section. According to the latest authority, it is interesting to note that the quassia now official in the U. S. P. is not a quassia at all, but a simaruba, for which the Pharmacopœia retains the name of *Picrasma excelsa.*

Powder.—Light yellow. Characteristic elements: Ducts large; with bordered pits and simple pores; wood fibers thin-walled, oblique pores; cells of medullary rays and crystal fibers with prisms of calcium oxalate; stone cells only present in bark tissue and in *Surinam quassia.*

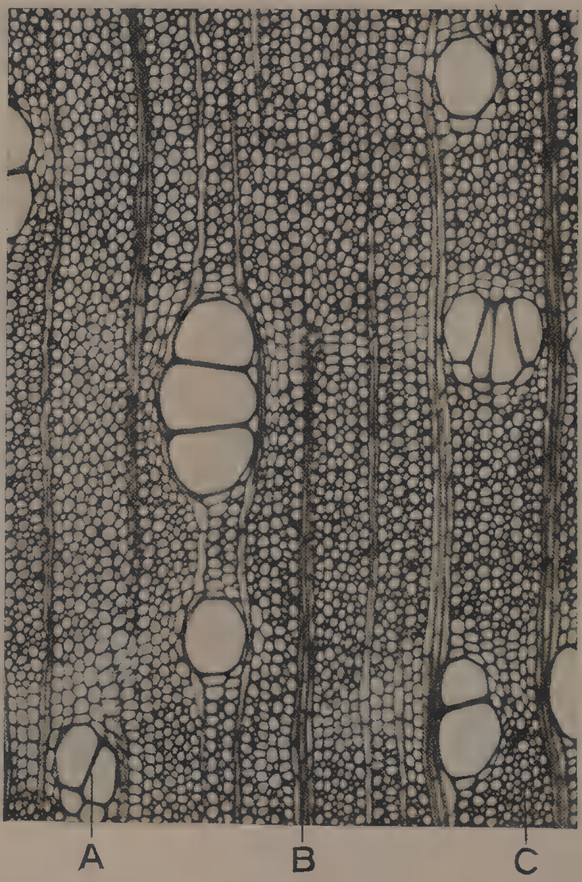

FIG. 63.—Quassia—Cross-section of wood. (65 diam.) A, Water tube. B, Medullary ray. C, Wood fibers. (Photomicrograph.)

CONSTITUENTS.—*Picras'ma excel'sa* contains a bitter neutral principle, picrasmin, *Quas'sia amar'a,* an analogous principle, quassin, both soluble in water, alcohol, and chloroform. The principles can easily be obtained from the precipitated tannate by mixing it with lead carbonate, drying, and extracting with alcohol. They crystallize from alcoholic solution in needles; purified by recrystallization. Quassia **contains no tannin,** and therefore can be prescribed with salts of iron.

Preparation of Quassin.—Neutralize infusion with NaOH; add tannin to precipitate the neutral principle; heat with lead oxide or lime to decompose precipitate, and dissolve out with alcohol. White, opaque, very bitter. Soluble in hot alcohol, chloroform; slowly in water.

Preparation of Picrasmin.—Precipitate tannate with lead acetate, the former obtained by precipitating the neutral infusion with tannin. In needles; very soluble in hot alcohol, chloroform, acetic acid, but sparingly in water.

ACTION AND USES.—A valuable simple bitter tonic. Dose: 15 to 60 gr. (1 to 4 Gm.). It is poisonous to insects, a strong infusion being often used as a parasiticide on animals.

OFFICIAL PREPARATIONS.

Extractum Quassiæ,	Dose:	1 to 3 gr. (0.065 to 0.2 Gm.).
Fluidextractum Quassiæ,		5 to 30 ♏ (0.3 to 2 Cc.).
Tinctura Quassiæ (20 per cent.),		30 to 60 ♏ (2 to 4 Cc.).

97. **QUASSIÆ CORTEX.**—QUASSIA BARK. The bark of **Picræ'na excel'sa** Lindley. In flat or curved pieces 5 mm. ($\frac{1}{5}$ in.) or more thick. The outer surface is of a dark gray color and longitudinally furrowed; inner surface yellowish-white and smooth; inodorous; very bitter. The bark of *Surinam Quassia* is much thinner. These barks have the same constituents and are used for the same purposes as the wood—as tonics.

98. **SIMARUBA.**—The root-bark of **Simaru'ba officina'lis** De Candolle. *Habitat:* Northern South America and West Indies. In curved or quilled pieces about 50 to 100 mm. (2 to 4 in.) long, and 3 mm. ($\frac{1}{8}$ in.) thick; it is of a yellowish-white color, generally deprived of the yellowish or brownish periderm; inner surface light brown, finely striate; bast coarsely fibrous, tough, flexible, the fibers easily separable; inodorous; very bitter. It contains probably quassin or picrasmin, some resin, and a trace of volatile oil. Tonic, used in dysentery and chronic diarrhea. Dose: 8 to 30 gr. (0.5 to 2 Gm.), in infusion or decoction.

99. **CEDRON.**—CEDRON SEED. From **Sima'ba ce'dron** Planch, a South American tree. These seeds are used by the natives as a remedy for the bite of poisonous serpents and insects. Cerebral sedative, antispasmodic, and antiperiodic; poisonous. Dose of fluidextract: 1 to 8 ♏ (0.065 to 0.5 Cc.).

100. **AILANTHUS.**—TREE OF HEAVEN. CHINESE SUMAC. The bark of **Ailanth'us glandulo'sa** Des Fontaines, a common shade tree. The powder is of a greenish yellow color, and has a strong, narcotic, nauseating odor. A powerful nerve-depressant and antispasmodic, used in asthma, hiccough, twitching of the muscles, epilepsy, etc. When chewed, it produces a general sense of uneasiness, weakness, dazzling, cold sweats, shivering, nausea, etc., similar to that produced by tobacco. These effects depend upon a volatile oil, which is so powerful that persons preparing the extract are often thus affected by the vapor. Dose: 15 to 30 gr. (1 to 2 Gm.).

101. **CASCARA AMARGA.**—HONDURAS BARK. From undetermined species of **Picram'næa.** A valuable alterative, claimed to be almost a specific in syphilitic affections; it contains an alkaloid, picramnine. The use of tobacco and alcohol is said to counteract its action. Dose: 30 to 60 gr. (2 to 4 Gm.).

101½. **CHAPARRO AMARGOSO.**—**Castela Nicholsoni** Hook. AMARGOSA. Bark of root. West Indies and along the Rio Grande in Mexico and Texas. *Preparation:* Fluidextract. *Properties:* Tonic, antiperiodic, astringent. *Uses:* Considered a specific for diarrhea. Dose: 30 to 60 minims. In pieces about ten inches long by one in width and a quarter in thickness. Outer portion composed of a corky layer $\frac{1}{24}$ inch thick and ash-gray in color. Inner side of a dirty yellowish color; slightly striated. Fracture brittle but fibrous. Slightly aromatic. Very bitter.

BURSERACEÆ.

Tropical trees and shrubs abounding in resinous and oily secretions. Drugs of the order are: *Myrrha* (102); *Olibanum* (103); *Bdellium* (104), and *Elemi* (105).

102. MYRRHA.—Myrrh.

MYRRH. *Ger.* MYRRHE.

A gum-resin exuding spontaneously from the stem of **Commiph'ora myr'rha** Engler and other species.

Botanical Characteristics.—A shrub forming the chief underwood of the Arabian and African forests along the shores of the Red Sea. Squamose, spinescent branches, with pale, ash-gray, odorous bark; *leaves* ternate; *flowers* solitary, greenish; *fruit* drupaceous, with the persistent calyx attached.

Fig. 64.—*Commiphora myrrha*—Branch.

Source.—Myrrh is now imported from the East Indies, where it is brought from Arabia and the northeastern coast of Africa. It is usually imported in chests containing from one hundred to two hundred pounds.

Description of Drug.—Irregular masses of agglutinated tears, varying from small grains up to pieces about the size of an egg, or sometimes much larger; of a reddish-yellow to a reddish-brown color, dusty, opaque, waxy, and unctuous. Freshly broken, the shining surface often shows characteristic white marks or streaks. Odor pleasant, balsamic; taste bitter, aromatic. This description applies to the best *Turkey*-official myrrh. The *India* variety comes in darker pieces, more opaque, less odorous, and abounding in impurities. Bdellium and other gummy or resinous

substances are often mixed with it. *False myrrh* is the name sometimes given to these other gummy and resinous substances. As it is difficult to detect adulteration when it is in the powdered form, it is best purchased in mass. The best variety yields a brownish-yellow tincture, which acquires a purple tint upon the addition of nitric acid. A tincture which does not show this color reaction betrays an impure article, which should be rejected.

CONSTITUENTS.—A **volatile oil,** myrrhol (3 to 4 per cent.); a bitter principle; a **resin,** 35 per cent., and **gum,** 60 per cent., forming with water a yellowish or brownish emulsion, which deposits a sediment upon standing. Recent investigations of Tschirch and others, have cleared up many obscure points regarding the chemistry of the resins in such drugs as myrrh. An excellent classification of the resins is found in a volume entitled "Pharmacopedia," by White and Humphrey, London. Myrrh of good quality should contain not more than 70 per cent. of matter insoluble in alcohol, and leave not more than 10 per cent. of ash.

ACTION AND USES.—A stomachic, carminative, and emmenagogue. Used mostly in mouth-washes. Dose: 2.5 to 15 gr. (0.15 to 1 Gm.), in pills and emulsion.

OFFICIAL PREPARATIONS.

Tinctura Myrrhæ (20 per cent.), ...Dose:	10 to 60 ♏ (0.6 to 4 Cc.).
Tinctura Aloes et Myrrhæ (10 per cent. of each, with glycyrrhiza 10 per cent.),	½ to 2 fl. oz. (2 to 8 Cc.).
Mistura Ferri Composita (1.8 per cent., with ferrous sulphate, potassium carbonate, sugar, spirits of lavender, and rose water), ...	½ to 2 fl. oz. (15 to 60 Cc.).
Pilulæ Aloes et Myrrhæ, 1 gr. (.06 Gm.),	2 to 5 pills.

103. **OLIBANUM.**—FRANKINCENSE. A gum-resin exuding from incisions into the bark of **Boswel'lia carte'rii** Birdwood. *Habitat:* Eastern Africa and Southern Arabia. In tears of various shapes, generally rounded; yellowish or pale brown, thickly covered with a white dust; fracture dull, waxy, pale yellowish or reddish; softens when chewed; odor agreeably aromatic, stronger on heating; taste terebinthinate, somewhat bitter, but not unpleasant. Contains a volatile oil, a gum resembling gum arabic, and a resin, forming with water a pure white emulsion. Rarely used medicinally; mostly used for fragrant fumigations and pastilles, and as an altar incense.

104. **BDELLIUM.**—A gum-resin obtained from **Commi'phora mu'kul** Hooker and from **C. africana** Engler. *Habitat:* (1) East India; (2) Western Africa. (1) Dusty pieces breaking with a dark brown, conchoidal fracture; translucent in thin sections; (2) irregular, dusty tears, breaking with a yellowish to brown-red, waxy, angular fracture. Contains resin, volatile oil, and gum. Odor and taste resemble myrrh. Used for the same purposes.

105. **ELEMI.**—MANILA ELEMI. An oleoresin exuding from incisions in **Cana'rium commu'ne** (?) Linné. *Habitat:* Philippine Islands. A soft, unctuous substance, colorless when pure, becoming firmer and yellow with age; often contaminated with carbonaceous matter, which renders it grayish or blackish. It has a strong, pleasant odor, like lemon and fennel; taste

bitter, disagreeable, and pungent. Contains volatile oil, resin, elemic acid, and breidin, a crystalline principle, soluble in water. Used in plasters and ointments as a stimulant and irritant.

MELIACEÆ.

Tropical trees, rarely undershrubs, with mostly pinnately compound leaves. The order contains many plants which have acrid, bitter, and astringent properties. None official.

106. **MAREGAMIA ALATA.**—GOANESE IPECAC. (Root.) *Habitat:* Western India. Expectorant and emetic. Dose: 1 to 3 gr. (0.065 to 0.2 Gm.); as an emetic, 5 to 10 gr. (0.3 to 0.6 Gm.).

107. **COCILLANA.**—The bark of an undetermined species of **Guarea,** a large Bolivian tree. It is a new drug and has not yet been fully tested, but experiments thus far have shown it to possess expectorant and emetic properties similar to ipecac. Dose of fluidextract: 10 to 30 ♍ (0.6 to 2 Cc.).

108. **AZEDARACH.**—MARGOSA BARK. The root-bark of **Me'lia azed'arach** Linné. *Habitat:* China and India; cultivated in Southern United States. Fibrous pieces about 5 mm. ($\frac{1}{5}$ in.) thick, and 50 to 75 mm. (2 to 3 in.) wide. The outer surface is reddish-brown, with irregular, blackish, longitudinal ridges. The inner surface is yellowish-white to brown, and striated longitudinally; fracture fibrous; inodorous; taste sweetish, acrid, and bitter. If collected from old roots, the bark must be freed from the corky layer. The active principle is a yellowish-white resin. Azedarach was once extensively used in the Southern States as an anthelmintic. Dose: 15 to 60 gr. (1 to 4 Gm.), in decoction.

ILICINEÆ.—Holly Family.

Trees and shrubs indigenous to tropical and temperate climates. Leaves coriaceous, evergreen.

109. **ILEX OPACA** Aiton.—HOLLY. (Leaves.) Petiolate, about 50 mm. (2 in.) long, leathery, smooth; inodorous; taste mucilaginous, bitter, and astringent. They contain a bitter principle, ilicin, and tannin. Demulcent, tonic, and emetic. Dose: 15 to 30 gr. (1 to 2 Gm.).

110. **ILEX PARAGUAYENSIS** Lambert. PARAGUAY TEA. (Leaves.) *Habitat:* Brazil and Argentine Republic. Lance-oblong, about 50 mm. (2 in.) long, on a short petiole; surface smooth; margin few-toothed. The maté of the market is a coarse, dark powder, slightly roasted, with a tea-like odor and a bitter, astringent taste. Contains caffeine, giving it properties differing only slightly from tea, for which it is used as a substitute by the natives.

111. **PRINOS.**—BLACK ALDER. WINTERBERRY. The bark of **I'lex verticilla'ta** Gray. *Habitat:* North America, in swampy thickets. Thin, yellowish-green fragments, usually deprived of the grayish or brownish periderm, which, when present, is marked with whitish patches and black lines and dots; inodorous; taste bitter and slightly astringent. It contains tannin, wax, sugar, resin, starch, chlorophyll, and a yellow, amorphous, bitter principle. Used as a tonic, antiperiodic, and astringent. Dose: 15 to 60 gr. (1 to 4 Gm.).

CELASTRINACEÆ.—Staff-tree Family.

Small trees and shrubs, sometimes climbing. *Leaves* alternate, rarely opposite, often coriaceous. A peculiarity of the *flowers* is that the perigynous stamens are inserted on the disk which fills the bottom of the calyx and sometimes covers the ovary. *Fruit* a capsule, an indehiscent drupe, or a samara. *Seeds* furnished with a pulpy, colored, cupular aril.

112. EUONYMUS.—Euonymus.

WAHOO. *Ger.* SPILLBAUMRINDE.

The dried bark of the root of **Euon'ymus atropurpu'reus** Jacquin.

Botanical Characteristics.—Tall, ornamental shrub, 6 to 14 feet high; *leaves* petiolate, oval-oblong; *flowers* dark purple, in fours; *pods* smooth, deeply lobed; *seeds* inclosed in a red aril. Ornamental in autumn from its copious crimson fruit, drooping in long peduncles.

Habitat.—United States.

Description of Drug.—In quilled or curved pieces about 2 mm. ($\frac{1}{12}$ in.) thick. The **periderm is of an ash-gray color, covered with blackish patches or ridges,** and removable in scales from the **whitish or yellowish-brown inner bark;** fracture, smooth and short. It contains a hygroscopic tissue, which readily absorbs moisture, thus becoming less brittle; odor distinct; taste sweetish, bitter and somewhat acrid. It is sometimes mixed with branches and pieces of the wood.

Fig. 65.—Cross-section of Wahoo bark. Magnified 15 diam.

Powder.—Light brown. Characteristic elements: Sclerenchyma consisting of long, thin-walled bast fibers; ducts and wood fibers sometimes present; spherical starch grains and rosette-shaped calcium oxalate crystals also present.

Constituents.—Its chief constituent of therapeutic value, **euonymin,** is bitter, amorphous, and precipitated from its solution by phosphomolybdic acid and lead subacetate. This product is not to be confounded with a resinoid of the same name (see below). The bark also contains atropurpurin, asparagin, euonic acid, fixed oil, and albumen.

Preparation of Euonymin.—Add chloroform to a dilute alcoholic tincture and shake; separate chloroformic solution and evaporate; treat residue with ether, then alcohol, and lead acetate; add H_2S to precipitate lead; finally evaporate. Soluble in ether, alcohol, and water. The eclectic resinoid, by this name, is a dried precipitate, resulting when concentrated alcoholic tincture is added to water.

ACTION AND USES.—A cholagogue cathartic in doses of 0.8 to 30 gr. (0.5 to 2 Gm.); also tonic and laxative.

OFFICIAL PREPARATIONS.

Extractum Euonymi (From Fl'ext.), . Dose: 1 to 5 gr. (0.065 to 0.3 Gm.).
Fluidextractum Euonymi, ... ½ to 2 fl.dr. (2 to 8 Cc.).

113. **CELASTRUS SCANDENS** Linné.—CLIMBING STAFF-TREE. FALSE BITTER-SWEET. *Habitat:* North America. (Root-bark.) Alterative, diaphoretic, diuretic, and emetic; has been used in chronic affections of the liver. Dose of fluidextract: 1 to 2 fl dr. (4 to 8 Cc.).

RHAMNACEÆ.—Buckthorn Family.

Shrubs or small trees with simple leaves; branches somewhat spinescent. *Flowers* somewhat diœcious. *Fruit* an indehiscent, fleshy, winged drupe, with a hard, woody endocarp, or a pod not arilled.

114. FRANGULA.—FRANGULA.

BUCKTHORN. *Ger.* FAULBAUMRINDE.

The dried bark of the stem and branches of **Rham'nus fran'gula** Linné, collected at least one year before using.

BOTANICAL CHARACTERISTICS.—An elegant arborescent shrub, known as the berry-bearing alder. *Leaves* entire, with about 7 pairs of nearly opposite parallel veins. *Flowers* perfect, style simple; the fleshy berry is round, red, and on ripening becomes black and juicy.

HABITAT.—Europe and Northern Asia.

DESCRIPTION OF DRUG.—Quilled, about 1 mm. ($\frac{1}{25}$ in.) thick; outer surface grayish-brown, or blackish-brown, with numerous small, whitish, transversely-elongated lenticels and occasional patches of foliaceous lichens; inner surface smooth, pale brownish-yellow; fracture in the outer layer short, of a purplish tint; in the inner layer fibrous and pale yellow; when masticated, coloring the saliva yellow; odor distinct; taste sweetish and bitterish.

Medullary rays not converging at the outer ends (distinction from *Rhamnus Purshiana*); stone cells absent (distinction from *Rhamnus Purshiana* and *Rhamnus Californica*).

Powder.—Light yellowish-brown, red with alkalies. Characteristic elements: The most prominent are the sclerenchyma with long, thick-walled bast fibers,

porous, with crystal fibers containing small crystals of calcium oxalate. Less important is the outer and inner bark cells, the latter are without coloring-matter.

CONSTITUENTS.—Frangulin, or rhamno-xanthin, $C_{20}H_{20}O_{10}$, is a crystalline, lemon-yellow, odorless, tasteless glucoside; and emodin, a reddish principle, exists in the old bark; these develop by age. Two

FIG. 66.—*Rhamnus frangula*—Branch.

products are obtained from frangulin by hydrolysis—emodin, $C_{15}H_{10}O_5$, and rhamnose, $C_6H_{12}O_5$. Frangula-emodin differs from the rhubarb-emodin in melting-point, and in some color reactions. Senna and aloes also contain an isomeric emodin. (See *Rhamnus Purshiana*.)

Preparation of Frangulin.—Macerate the bark for four days in carbon disulphide. Evaporate; exhaust residue with alcohol; evaporate alcoholic solution

to dryness; crystallize from ethereal solution. Forms sublimable yellow crystals; becomes purple when treated with alkalies. Dyes cotton, silk, wool, etc., yellow.

ACTION AND USES.—A mild laxative or cathartic, acting like senna and often used in its stead. Dose: ½ to 2 dr. (2 to 8 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Frangulæ, ...Dose: ⅓ to 2 fl. dr. (1.3 to 8 Cc.).

115. RHAMNUS PURSHIANA.—CASCARA SAGRADA.

CHITTEM BARK.

The dried bark of **Rham'nus purshian'a** De Candolle, collected at least one year before using.

BOTANICAL CHARACTERISTICS.—Plants of this species of Rhamnus attain a height of 10 to 20 feet. The *leaves* are ovoid, 3 to 5 in. in length, and about ½ in. in their greatest width, serrate except at base. *Flowers* are small and white, appearing after the leaves have matured. The *fruit* is a plain,

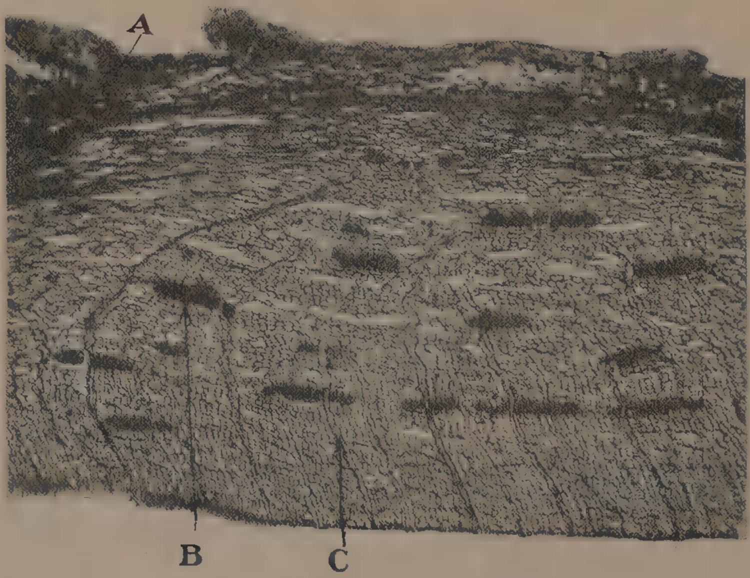

FIG. 67.—*Rhamnus frangula*—Cross-section of bark. (37 diam.) A, Cork. B, Group of bast fibers. C Medullary ray. (Photomicrograph.)

round, black berry about ¼ in. in diameter, and contains three seeds. This species differs from other species of Rhamnus in that it is a larger tree and bears a larger fruit.

SOURCE.—Several allied species growing in the cascara district in California seem to contribute the cascara sagrada bark of the market. The official species grows abundantly in Northern California, Oregon, and Washington. "If the bark comes and is actually collected from

Northern California, it is presumptive evidence that it is genuine. The probabilities of adulteration increase with its southward sources, and if collected in, or south of, Central California, it is to be looked upon with greatest suspicion" (Rusby).

DESCRIPTION OF DRUG.—Curved pieces or quills 1 to 4 mm. ($\frac{1}{25}$ to $\frac{1}{6}$ in.) thick, and about 100 mm. (4 in.) long. The outer surface is reddish brown, frequently more or less covered with grayish or whitish lichens, the young bark having numerous rather broad, pale-colored warts; sometimes mottled or figured; inner surface smooth and finely striate,

FIG. 68.—*Rhamnus purshiana*—Branch.

yellowish, turning brown or nearly black on exposure; fracture short, yellowish, of the inner layer somewhat fibrous and thick. A cross-section shows numerous thin, almost straight, broadening medullary rays, which run on an average about three-fourths of the distance across the bark. Medullary rays in groups converging at their outer ends (distinction from *Rhamnus Californica*); stone cells present (distinction from *Rhamnus frangula*). If to a small quantity of the powdered barks an alkaline solution be added, the color developed in the *Rhamnus Californica* is a deep red, while that of *R. Purshiana* is orange. Odor distinct; taste bitter and slightly acrid.

Powder.—Yellowish-brown, colored dark orange by alkalies. Characteristic elements: Parenchyma of cortex with starch, spherical, about 4 μ in diam., yellow coloring-matter, and aggregate calcium oxalate (10 to 15 μ in diam.); sclerenchyma with bast fibers slender, thick-walled, porous; stone cells, about 50 μ in diam.: also crystal bearing fibers, with prisms of calcium oxalate (6 to 10 μ in diam.).

CONSTITUENTS.—Emodin and frangulic acid; frangulin and purshianin —the two latter being glucosides, yielding, on hydrolysis, emodin and sugar. The principle, emodin, is found in many purgative drugs. Its composition, and its relation to several carbon compounds are shown in the following:

$C_{14}H_{10}$	$C_{14}H_8O_2$	$C_{14}H_6(OH)_2O_2$	$C_{14}H_4CH_3(OH)_3O_2$
Anthracene	Anthraquinone	Chrysophanic Acid	Emodin

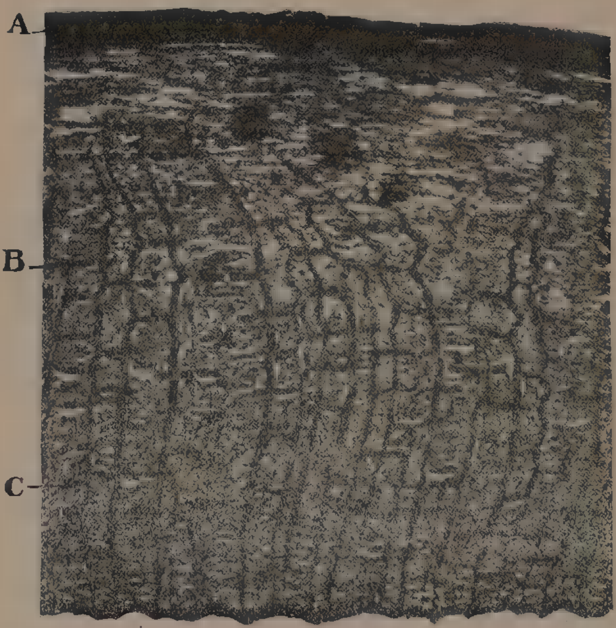

FIG. 69.—*Rhamnus purshiana*—Cross-section of bark. (20 diam.) A, Cork. B, Group of bast fibers and stone cells. C, Medullary ray. (Photomicrograph.)

Emodin is therefore said to be a trioxy-methyl-anthraquinone. It is contained in rhubarb, senna, aloes, etc. The resins are turned a vivid purple-red by caustic potash. The fresh bark is active as a purgative, causing much griping. By keeping and properly curing, however, this griping principle is destroyed, and the bark becomes more accurate in action and less likely to cause this discomfort.

Purshianin is a glucoside reported by Dohme and Englehardt. Obtained by first removing oil, etc., from the drug by means of chloroform, then extracting the residue with alcohol, etc. It crystallizes from acetone and ethylic acetate in dark brown-red needles, melting at 237°. On heating with alcoholic hydrochloric acid it yields sugar and emodin.

ACTION AND USES.—A valuable laxative in chronic constipation. Dose: 30 to 60 gr. (2 to 4 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Rhamni Purshianæ Aromaticum, ...Dose: Same as Fl'ext.
Fluidextractum Rhamni Purshianæ, ... 15 to 45 ♏ (1 to 3 Cc.).

116. **RHAMNUS CATHARTICA.**—BUCKTHORN. The fruit of **Rham'nus cathar'tica** Linné. *Habitat:* Europe, Northern Asia, and naturalized in North America. Small, berry-like fruits about the size of a pea, borne on a receptacle at the end of a slender stalk; apex tipped with the style remnants. Smooth, purplish or black when fresh, in which state they are generally used; wrinkled on drying; four-celled, each containing a single triangular seed, surrounded by a brownish-green pulp; odor unpleasant; taste sweetish, afterward bitter and nauseous. They contain rhamnocathartin, rhamnin, sugar, gum, and tannin. A syrup is made from the juice, having strong purgative properties. Dose of syrup: 2 to 5 fl. dr. (8 to 20 Cc.). The green fruit treated with lime yields a pigment, sap-green.

117. **CEANOTHUS.**—NEW JERSEY TEA. RED ROOT. The root of **Ceano'thus america'na** Linné. *Habitat:* North America. About 300 mm. (12 in.) long, and 12 to 25 mm. (½ to 1 in.) thick, contorted and knotty; bark reddish-brown, thin, inclosing a tough, light brown wood, finely rayed; odor none; taste astringent and bitter. It contains ceanothine, tannin, mucilage, etc. Astringent and expectorant. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

118. **GOUANIA.**—CHEWSTICK. The stems of **Goua'nia domingen'sis** Linné. *Habitat:* West Indies. Brownish-gray, wrinkled pieces of the stems, with a thin bark, and a yellowish-gray, fibrous, porous wood. It contains a bitter principle and is used as a tonic.

AMPELIDEÆ.

Mostly climbing shrubs. *Stems and branches* nodose; tendrils and flower clusters opposite the leaves. *Fruit* a two-celled berry. Plants abounding in the Tropics.

119. **UVA PASSA.**—RAISIN. The dried fruit of **Vi'tis vinif'era** Linné. *Habitat:* Western Asia, Europe, and California; the Valencia raisins are the kind generally used in pharmacy. Shriveled and pressed; brown, slightly translucent; internally pulpy, two-celled, with two seeds in each cell; taste sweet. Chiefly used as an agreeable saccharine addition to preparations.

120. **AMPELOPSIS QUINQUEFOLIA** Michaux.—AMERICAN IVY. WOODBINE. (Root-bark.) Alterative, tonic, astringent, and expectorant. Dose of fluidextract: 30 to 60 ♏ (2 to 4 Cc.).

SAPINDACEÆ.—Soapberry Family.

Trees or shrubs, rarely herbs. Stem with watery juice, erect or climbing. The members of the order are called soapworts because of the *fruit of many species containing a saponaceous principle.* The flowers are unsymmetrical, racemed, or panicled, the pedicels often changed into tendrils. The order furnishes a variety of dissimilar products, as will be seen in *Guarana*, 121; *Æsculus glabra*, 122; *Æsculus hippocastanum*, 123; *Acer rubrum*, 124; and *Macassar oil*, 125.

121. GUARANA.

GUARANA. *Ger.* GUARANA.

A dried paste consisting chiefly of the crushed or pounded seeds of **Paullin'ia cupan'a** Kunth, yielding, by the official process, 3.5 per cent. of total alkaloids.

BOTANICAL CHARACTERISTICS.—A climbing shrub with alternate, imparipinnate leaves on long stalks, with five oblong-oval, irregularly sinuate-dentate leaflets 5 to 6 in. long and 2 to 3 in. broad, contracted into a shortly attenuated blunt point. *Flowers* in axillary spicate panicles. *Fruit* ovoid or pyriform, about the size of a grape, with a short, strong beak, and six longitudinal ribs. *Pericarp* thin, leathery, hairy inside, inclosing lenticular, thorny seeds resembling small horse-chestnuts, and each invested with an easily removed, flesh-colored aril.

HABITAT.—Brazil.

DESCRIPTION OF DRUG.—In **cylinders, cakes,** or **balls** of a dark reddish-brown color, not infrequently met with in the form of a light **reddish-brown** powder. In preparing the cylinders, etc., above referred to, the seeds deprived of arilode (papery shell) of the plant are first roasted, then ground, kneaded with water in a heated mortar into a pasty and pliable dough, made into forms, and dried. The forms thus made break with an uneven fracture, black-mottled from fragments of seeds. The drug has a peculiar characteristic chocolate-like odor and a bitter, astringent taste afterwards sweetish.

Powder.—Reddish-brown; pasty. Characteristic elements: parenchyma thin-walled, rather large, brown cells, with starch about 10 μ; sclerenchyma with stone cells nearly isodiametric, and bast fibers few, narrow; ducts few, annular, scalariform.

CONSTITUENTS.—Tannic acid, not precipitated by tartar emetic or copper, gum, albumen, starch, a trace of volatile oil, saponin, a greenish fixed oil, and **guaranine,** an alkaloid identical with caffeine or theine. Of this it contains a much larger percentage as compared with other caffeine-yielding drugs. For example, good black tea gave 2.13 per cent.; coffee, 1 per cent.; Paraguay tea, 1.2 per cent., and guarana, 5.07 per cent.—a rather large yield for the latter.

Preparation of Guaranine.—Treat the powder with boiling water. Evaporate the decoction on a water-bath to dryness, and exhaust the residue with chloroform. Distil off chloroform, treat residue with boiling water, filter, and evaporate the liquid to obtain caffeine (guaranine). Tea and kola can be treated in the same way for their active constituents.

ACTION AND USES.—Stimulant, especially beneficial in nervous headache, and used like tea, coffee, and other drugs containing caffeine-like principles. Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Guaranæ, ... Dose: 15 to 60 ♏ (1 to 4 Cc.).

122. **ÆSCULUS GLABRA** Willdenow.—OHIO BUCKEYE. (Bark.) It has an especial action on the portal circulation and the liver, and promotes the biliary secretions. Dose of fluidextract: 3 to 5 ♏ (0.2 to 0.3 Cc.).

123. **ÆSCULUS HIPPOCASTANUM** Linné.—HORSE-CHESTNUT. (Bark and Fruit.) *Habitat:* Asia; cultivated as an ornamental tree in Europe and North America. The bark contains a bitter glucosid, esculin, isomeric with quinovin in cinchona bark, for which it is used as a substitute in Europe. It is tonic, astringent, antiperiodic, narcotic, and antiseptic. The nuts have a similar action, but in addition are antispasmodic, used chiefly in neuralgic affections. The administration of the fluidextract has been recently recommended as a palliative in hæmorrhoids. Dose of bark: ½ to 2 dr. (2 to 8 Gm.); of the nuts: 5 to 15 gr. (0.3 to 1 Gm.), generally in fluidextract.

Preparation of Esculin.—Precipitate a decoction of the bark with lead acetate, treat the filtrate with H_2S, evaporate and recrystallize.

124. **ACER RUBRUM** Linné.—RED OR SWAMP MAPLE. The bark of this indigenous maple was the favorite remedy of the Indians for sore eyes; it is a mild astringent.

125. **MACASSAR OIL.**—A fixed oil expressed from the seeds of **Schlerche'ra triju'ga** Willdenow, a small East Indian tree which is also a source of lac. This oil has a great reputation in its native country as a stimulating application to promote the growth of the hair, and also as a remedy in skin diseases, especially eczema.

ANACARDIACEÆ.—Cashew Family.

Trees or shrubs with gummy, milky or resinous juice, often poisonous. *Leaves* usually compound. *Fruit* drupaceous, not infrequently having a strong turpentine odor and taste. The *seeds* of many species yield an abundance of bland oil. Drugs from the order: *Rhus Toxicodendron*, 126; *Rhus Glabra*, 127; *Rhus aromatica*, 128; *Mastiche*, 129; *Terebinthina Chia*, 130; *Anacardium*, 131; *Semecarpus*, 132.

126. **RHUS TOXICODENDRON.**—POISON IVY. POISON OAK. The fresh leaves of **Rhus rad'icans** Linné. Off. U. S. P. 1890. The leaves are trifoliate, the terminal leaflet ovate, stalked, the lateral ones sessile, obliquely ovate. These leaflets are about 100 mm. (4 in.) in length, with margins entire, or coarsely toothed or indented; odorless; taste bitter, acrid, and astringent. The dried leaves are brittle and papery, of a pale green color. *Constituents:* The fresh leaves abound in an acrid, milky juice, which blackens on exposure to the air, and in contact with the skin causes inflammation and swelling. The acridity is due to what was formerly termed toxicodendric acid, the vapor of which was said to be the cause of vesicular eruptions, but this principle has been found to be, by Pfaff and Balch, an oil, which was given the name "toxicodendrol." It is very volatile, and is, therefore, nearly absent in the dried leaves, rendering them almost inert. They also contain a tannin producing greenish precipitates with iron salts, wax, fixed oil, resin, etc.

Preparation of Toxicodendric Acid.—To bruised leaves add $Ca(OH)_2$; macerate with water; express; add H_2SO_4; distil. The condensed vapor is a very acrid liquid (see above), which causes the characteristic vesicular eruption of ivy-poison.

Local irritant and rubefacient. Used in treatment of eczema, but is no longer in vogue. Dose: 1 to 5 gr. (0.065 to 0.3 Gm.).

127. RHUS GLABRA.—Rhus Glabra.

SUMAC. *Ger.* SUMACH.

The dried fruit of **Rhus gla'bra** Linné.

Botanical Characteristics.—Spreading shrub of thickets and waste grounds, with smooth branches, odd, pinnate *leaves* of 11 to 31 leaflets, and greenish *flower*, succeeded by hairy, crimson, berry-like *drupes*, in large, terminal thyrsoid pannicles.

Habitat.—North America.

Description of Drug.—Berries (drupes) about 3 mm. ($\frac{1}{8}$ in.) in diameter, densely **covered with a dark-red down.** The sarcocarp (the outer portion of a stone fruit) is composed of two layers, the outer being crimson, and the inner whitish; putamen (stone) flattish, ovoid, smooth. Inodorous; taste acidulous and astringent.

Powder.—Dark reddish-brown. Characteristic elements: Thick-walled cells of testa, porous; many celled trichomes deep red in color; seldom dispensed as powder.

Constituents.—The acidity of the fruit is due to the **acid calcium and potassium malates** present; there are also tannic and gallic acid, a red coloring-matter, etc.

Action and Uses.—Astringent and refrigerant. Used as a gargle in the form of decoction or fluidextract. Dose: 30 gr. (2 Gm.).

Official Preparation.

Fluidextractum Rhois Glabræ, ...Dose: 1 to 2 fl. dr. (4 to 8 Cc.).

128. **RHUS AROMATICA** Aiton (Var. Trilobata Gray).—Sweet Sumach. An indigenous bush, with leaves smaller than those of *R. glabra*, and unpleasantly scented. (Root-bark.) It acts as an excitant to the unstriped muscular fiber, particularly of the bladder, and is therefore an efficient remedy in incontinence of urine. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

129. MASTICHE.

MASTIC. *Ger.* MASTIX.

A concrete resinous exudation from **Pista'cia lentis'cus** Linné.

Botanical Characteristics.—A shrub about 12 feet high; *leaflets* 8 to 10, small, oval-lanceolate; petiole winged. *Flowers* diœcious, small, apetalous; males in compound amentaceous racemes, females in more lax compound racemes. *Fruit* a small, roundish drupe, brownish-red.

Habitat.—Mediterranean Basin, produced chiefly in the island of Scio.

Description of Drug.—A handsome-appearing resin, globular, somewhat elongated, **yellowish, translucent tears** about the **size of a**

pea, brittle, and dusty from powder derived from attrition; **plastic when chewed;** odor balsamic; taste slight turpentine-like and faintly bitter. Soluble in ether and nearly so in alcohol.

CONSTITUENTS.—Volatile oil 1 to 2 per cent., and two resins, mastichic acid (alpha-resin), soluble in alcohol, and masticin (beta-resin), insoluble in alcohol, but soluble in ether.

FIG. 70.—*Pistacia lentiscus*—branch.

ACTION AND USES.—Mild stimulant, but rarely used internally. Dose: 30 gr. (2 Gm.). Used as a filling for carious teeth, and for making paints, varnishes, etc.

OFFICIAL PREPARATION.

Pilulæ Aloes et Masticles (.04 Gm.), ... Dose: 2 to 5 pills.

130. **TEREBINTHINA CHIA.**—CHIAN TURPENTINE. An oleo-resin from **Pista'cia terebin'thus** Linné, a tree growing on the island of Scio. Incisions are made and the exuding juice is allowed to fall upon smooth stones. It is a greenish-yellow, pellucid, syrupy liquid, hardening to a transparent mass when exposed by the evaporation of its volatile oil; odor fennel-like; taste bitterish. It is used for destroying cancerous growths, in which

it is claimed to be very efficient. Dose: 5 to 20 gr. (0.3 to 1.3 Gm.), in emulsion.

131. **ANACARDIUM.**—CASHEW NUT. The fruit of **Anacar'dium occidenta'le** Linné. *Habitat:* North America. Kidney-shaped, about 25 mm. (1 in.) long, invested with a grayish-brown, finely punctate pericarp containing cardol (a reddish-yellow fixed oil, very active and poisonous). The seed is white and consists principally of a bland fixed oil. Vermifuge and escharotic.

132. **SEMECARPUS.**—ORIENTAL CASHEW NUT. The fruit of **Semecar'pus anacar'dium** Linné, growing in Eastern India, a heart-shaped, somewhat flattened nut, about 20 mm. ($\frac{4}{5}$ in.) long, invested with a blackish-brown pericarp containing a brown, acrid, vesicating oil. Used as a local irritant.

LEGUMINOSÆ.—Pulse Family.

Herbs, shrubs, or trees with alternate and usually compound leaves. *Flowers* papilionaceous, or rarely regular. *Stamens* usually ten and mostly monadelphous or diadelphous. *Pistil* becoming in fruit a legume, from which the order takes its name. Most of the plants are innoxious; the marked exception to the rule, however, is the calabar bean.

Synopsis of Drugs from the Leguminosæ.

I. Cellular.

GLYCYRRHIZA,	Root,	133.	Stylosanthes,	Herb,	147.
Abri Radix,	"	134.	Galega,	"	147 a.
Baptisia,	"	136.	Trifolium Pratense,	"	146.
Erythrophlœum,	Bark,	137.	Trifolium Repens,	"	146 a.
Cercis,	"	138.	**SCOPARIUS,**	"	148.
Saraca,	"	139.	**CASSIA FISTULA,**	Fruit,	149.
Piscidia,	"	140.	Ceratonia,	"	150.
HÆMATOXYLON,	Wood,	141.	**TAMARINDUS,**	"	151.
SANTALUM RUBRUM,	"	142.	Dipteryx,	"	152.
SENNA,	Leaves,	143.	Abri Semen,	Seed,	135.
Cassia Marilandica,	"	144.	Fœnum Græcum,	"	153.
Melilotus,	Herb,	145.	**PHYSOSTIGMA,**	"	154.
			Mucuna,	Hairs,	155.

II. Non-cellular.

Araroba,	Powder,	156	**OLEUM COPAIBÆ,**	Volatile Oil,	161 a.
ACACIA,	Gum,	157.	Pongamia,	Fixed Oil,	162.
TRAGACANTHA,	"	158.	Copal,	Resin,	163.
CATECHU (Gambir),	Extractive,	159.	**BALSAMUM PERUVIANUM,**	Balsam,	164.
KINO,	"	160.	**BALSAMUM TOLUTANUM,**	"	165.
EXTRACTUM GLYCYRRHIZÆ,	"	133 a.			
COPAIBA,	Oleo-resin,	161.			

133. GLYCYRRHIZA.—GLYCYRRHIZA.

LICORICE ROOT. *Ger.* SÜSSHOLZWURZEL.

The dried rhizome and root of **Glycyrrhi'za gla'bra** Linné, and **Glycyrrhiza glandulif'era** Waldstein et Kittaibel. Spanish and Russian respectively.

BOTANICAL CHARACTERISTICS.—Plants 4 to 5 feet high. *Leaves* imparipinnate; *leaflets* about 13, oval. *Racemes* axillary, *flowers* distinct, pale blue. *Legume* ovate, compressed.

SOURCE.—Russia exports the largest amount, Syria the smallest. Partiality for the Spanish root is now unwarranted; the close digging, and the limited and practically exhausted fields of Spain are the causes of its deterioration. Russia, with its new and almost unlimited fields, furnishes roots rich in glycyrrhizin and extractive, much better suited for commercial purposes because better and cheaper than the Spanish root. Anatolian root ranks between the

FIG. 71.—*Glycyrrhiza glabra*—Branch.

Spanish and Russian in the quality of sweetness. In commerce no attention is paid to the botanical varieties of licorice root. From the root alone it is quite impossible to determine its true botanical origin, the usual designation being from the countries of growth, as Spanish, Russian, Anatolian, etc., although all varieties except the Spanish are often classified as "Greek root." Peeled root may now be prepared in Russia, but Syria formerly prepared it for shipment to

Europe, some of which found its way into the market as "peeled Russian." This has always commanded a good price. Batoum is the principal point of export for the Russian root, which is gathered along the Trans-Caucasian Railway, running from Batoum on the Black Sea to Baku on the Caspian Sea. The port of export for Anatolia is Smyrna, while the Spanish root finds its way into commerce through the principal seaports of Spain.—Amer. Jour. Pharm., 1897, p. 13.

DESCRIPTION OF DRUG.—**Long, cylindrical pieces** from 5 to 25 mm. ($\frac{1}{5}$ to 1 in.) in diameter; **externally dark-brown, longitudinally**

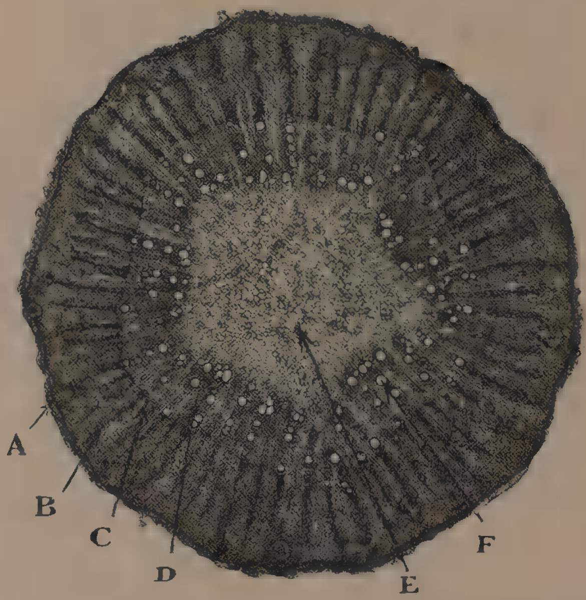

FIG. 72.—Glycyrrhiza—Cross-section of root. (13 diam.) A, Cork. B, Parenchyma of cortex. C, Medullary ray. D, Xylem. E, Medulla. F, Water tube. (Photomicrograph.)

wrinkled; internally of a light-yellow color; pliable, **fibrous,** tough, readily **tearing into long, fibrous strips.** Odor peculiar, earthy; taste sweetish, afterward acrid. A **cross-section** shows a rather thick bark, the inner layer of which is composed principally of bast fibers. The **meditullium is made up of three kinds of cells,** ligneous, with oblique ends, parenchymatous, almost cubical, and large pitted ducts giving to the wood a porous appearance. Wood-wedges narrow, separated by distinct medullary rays.

Glycyrrhiza glandulifera, so-called Russian, is thicker, less sweet, and more acrid than *G. glabra* (Spanish).

Powder, yellow. Characteristic elements: parenchyma of cortex thin-walled, medium sized, with simple, few compound, spheroidal starch grains 2 to 20 μ in diam. and calcium oxalate prisms; sclerenchyma with long bast

fibers 15 to 20 μ thick, thick-walled, some not strongly lignified. Ducts reticulate, porous, 60 to 175 μ broad; cork abundant in unpeeled root; crystal fibers, in connection with bast fibers, containing prisms of calcium oxalate.

Acid an

CONSTITUENTS.—**Glycyrrhizin,** asparagin, glycyramarin, an acrid resin, starch, etc. Glycyrrhizin is a glucosid, sparingly soluble in alcohol and ether, splitting up by hydrolysis into sugar and a brownish-yellow bitter substance, glycyrrhetin; it probably exists in combination with ammonia.

Preparation of Glycyrrhizin.—Obtained from the cold infusion (from which albumen has been removed by heat) by precipitating with H_2SO_4. Purify precipitate by dissolving in very weak ammonia water 1 to 10, filtering, and evaporating.

ACTION AND USES.—Expectorant and demulcent in bronchial affections. Generally used to disguise the disagreeable taste of other medicines. Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Glycyrrhizæ,	Dose: 15 to 60 ♏ (1 to 4 Cc.).
Extractum Glycyrrhizæ Purum,	5 to 60 gr. (0.3 to 4 Gm.).
Mistura Glycyrrhizæ Composita (3 per cent. of extract, with wine of antimony, paregoric, sweet spirits of niter, syrup, and mucilage of acacia),	2 to 6 fl. dr. (8 to 24 Cc.).
Glycyrrhizinum Ammoniatum,	5 to 15 gr. (0.3 to 1 Gm.).
Pulvis Glycyrrhizæ Compositus (23.6 per cent., with senna, washed sulphur, oil of fennel, and sugar),	½ to 2 dr. (2 to 8 Gm.).

Besides these it forms a sweetening ingredient in many other official preparations.

EXTRACTUM GLYCYRRHIZÆ, U. S.—Extract of Licorice. Made by evaporating the aqueous extract of the root. It is found in market in black, brittle, cylindrical rolls about 150 mm. (6 in.) long; flexible when warm, but when dry breaks with a brittle, conchoidal fracture, showing a glossy surface; odor characteristic; taste sweet. It yields a brown powder. It contains glycyrrhizin, both free and combined with ammonia, to which combination its sweetness is due, glycyrrhizin itself being almost tasteless. It is an excellent demulcent, the presence of a small piece in the mouth often allaying cough by coating and thus protecting the irritated membrane. Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATIONS.

Trochisci Ammonii Chloridi (each troche containing about 3 grains each of glycyrrhiza and 1½ of ammonium chloride, with sugar, tragacanth, and syrup of tolu),	Dose: 1 or 2 troches
Trochisci Glycyrrhizæ et Opii ($\frac{1}{12}$ gr. Pulv. opii),	1 or 2 troches.

134. **ABRI RADIX.**—INDIAN LICORICE. The root of **A'brus precato'rius** Linné, indigenous to India, naturalized in most tropical countries. Reddish-brown, twisted pieces, having a thin bark, and a meditullium composed of alternating zones of porous wood-bundles and parenchyma, traversed by medullary rays. Inodorous; taste bitter, afterward sweetish. It is thought to contain glycyrrhizin, and is used as a demulcent like glycyrrhiza.

135. **ABRI SEMEN.**—PRAYER BEADS. JEQUIRITY. The seeds of **A'brus precato'rius** Linné. Subglobular, about 5 to 8 mm. ($\frac{1}{5}$ to $\frac{1}{3}$ in.) long, scarlet-red, glossy, with a black spot at the hilum; inodorous; taste bean-like. They contain two proteids, paraglobulin, and albumose, which are irritating to the eyes. A weak infusion of the seed is used in granular ophthalmia.

136. **BAPTISIA.**—WILD INDIGO. The root of **Bapti'sia tincto'ria** R. Brown. *Habitat:* United States. It contains baptisine (acrid, poisonous), baptisin (a bitter glucoside), and baptin (a purgative glucoside). Chiefly used for its antiseptic properties, in lotion and ointment, although it acts also as an emetic and cathartic. Dose: 5 to 15 gr. (0.3 to 1 Gm.).

137. **ERYTHROPHLŒUM.**—SASSY BARK. A poisonous bark from **Erythrophlœ'um guineens'e** Don, used as an ordeal in Africa, where the tree grows, and therefore sometimes called doom-bark. It is in thick, warty, curved pieces, reddish-brown, fissured. Inodorous; taste astringent and bitter. It contains an alkaloid, **erythrophleine,** which **gives it an action on the heart similar to digitalis;** also astringent, emetic, diaphoretic, and analgesic. Dose: 5 to 15 gr. (0.3 to 1 Gm.).

Preparation of Erythrophleine.—Treat concentrated aqueous solution of the alcoholic extract of the bark with ammonia and exhaust the mixture with acetic ether. The alkaloid is yielded on evaporation.

138. **CERCIS CANADENSIS** Linné.—REDBUD. The bark of this indigenous tree has been recommended as a mild, non-irritating, but active astringent in diarrhea and dysentery. Also used as a local application to mucous membranes. Dose of fluidextract: 15 to 60 ♏ (1 to 4 Cc.).

139. **SARACA INDICA** Linné.—ASOCA. (Bark.) Much employed by the Hindoo physicians as a sedative in the treatment of uterine affections; it is also astringent. Dose of fluidextract: 15 to 60 ♏ (1 to 4 Cc.).

140. **PISCIDIA.**—JAMAICA DOGWOOD. The bark of **Piscid'ia erythri'na** Jacquin. *Habitat:* West Indies. Quills or curved pieces about 4 mm. ($\frac{1}{6}$ in.) thick; externally of a dark, yellowish-gray color, ridged longitudinally. **Odor opium-like when broken.** Taste bitter, acrid, producing a burning sensation in the mouth. Used as a **mild soporific for children and aged persons,** and for those not able to bear a strong narcotic like opium. Dose: 15 to 45 gr. (1 to 3 Gm.).

141. HÆMATOXYLON.—HÆMATOXYLON.

LOGWOOD. *Ger.* CAMPECHEHOLZ.

The heart-wood of **Hæmatox'ylon campechia'num** Linné.

BOTANICAL CHARACTERISTICS.—A tree of moderate size. *Leaves* 2 to 4 from the same point, pinnate; *leaflets* 2 to 4 pairs, obovate or obcordate. *Flowers* racemose, yellow. *Legume* small, compressed, lanceolate, pointed at each end, two-seeded.

HABITAT.—Central America.

DESCRIPTION OF DRUG.—Usually found in commerce in the form of

deep, brownish-red chips. When the surface has a greenish metallic luster, the wood has undergone fermentation and should be rejected. Odor slight; taste sweetish, astringent.

CONSTITUENTS.—**Hæmatoxylin,** $C_{16}H_{14}O_6$, sweet, colorless crystals, giving to the wood its characteristic colors by the combined action of the oxygen of the air and the alkaline bases existing in the wood; it is readily soluble in hot water and alcohol, sparingly in cold water;

FIG. 73.—*Hæmatoxylon campechianum*—Branch.

by the action of ammonia and oxygen in the air dark purple scales of hæmatein, $C_{16}H_{12}O_6$, are formed, often observable as the fine greenish hue upon logwood chips. This principle gives a blue color with alkalies. Hæmatoxylon also contains tannin, fat, resin, and a trace of volatile oil. With an alkali hæmatoxylon gives a purple color, brazil-wood a red color, and red saunders is not affected.

Preparation of Hæmatoxylin.—To ethereal extract add water and allow to crystallize; add a little H_2SO_3 or sulphite to prevent oxidation. Yellowish prisms of sweetish taste, violet-blue, with alkalies. Soluble in alcohol and water. Sunlight causes a red color.

ACTION AND USES.—A mild astringent. Dose: 30 to 60 gr. (2 to 4 Gm.),

in decoction or extract. A solution of hæmatoxylon as a staining fluid in microscopy is one of the most useful, as it stains both lignified

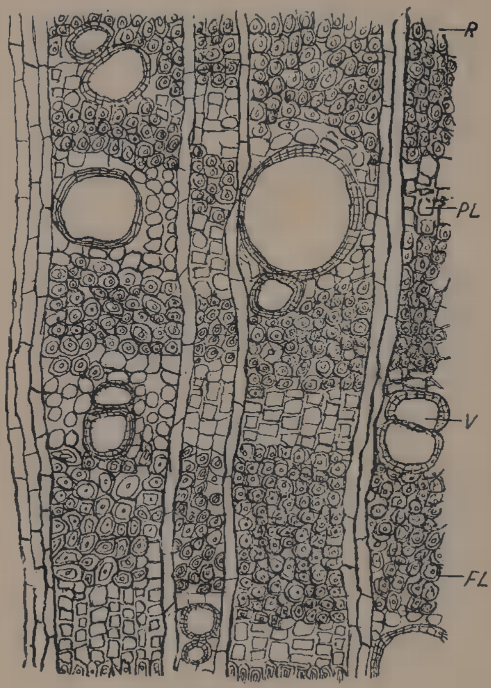

FIG. 74.—*Hæmatoxylon*—Cross-section of wood. *R*, Medullary ray, consisting of two vertical rows of cells, to which the black line from *R* should be extended. *V*, Pitted vessels. *FL*, Ligneous fibers. *PL*, Wood parenchyma.

and cellulose tissue, but not suberin or cutin. It is also one of the very best nuclear stains.

OFFICIAL PREPARATION.

Extractum Hæmatoxyli,............Dose: 5 to 10 gr. (0.3 to 0.6 Gm.).

142. SANTALUM RUBRUM.—RED SAUNDERS.

RED SANDALWOOD. *Ger.* ROTHES-SANTELHOLZ.

The heart-wood of **Pterocar'pus santali'nus** Linné.

BOTANICAL CHARACTERISTICS.—A large tree with dark red, heavy, and compact wood; a reddish juice exudes from its bark. *Racemes* axillary; *flowers* yellow, streaked with red. *Legumes* orbicular.

HABITAT.—Madras.

DESCRIPTION OF DRUG.—In commerce usually in deep reddish-brown raspings or small chips, or a coarse powder; tasteless and nearly odorless. The wood consists mostly of the lower parts of the stem, and thick roots, imported in irregular logs of various sizes, usually

deprived of the bark, and externally of a dark-brown color; internally of a rich red color, showing in transverse sections circles of a lighter tint. Used in Compound Tincture of Lavender (1 per cent.).

CONSTITUENTS.—The most important constituents are the **red coloring-matter, santalin,** in needles, soluble in alcohol, ether, acetic acid, and alkaline solutions, but insoluble in water, and only slightly

FIG. 75.—*Pterocarpus santalinus*—Branch.

soluble in boiling water and santalic acid, $C_{15}H_{14}O_5$. The yellow ethereal solution is turned to violet by alkalies. Santol, pterocarpin, and homopterocarpin are also constituents.

Preparation of Santalin.—Precipitate alcoholic tincture with lead acetate; decompose this precipitate with H_2S in presence of alcohol and evaporate. Red needles are obtained, which are inodorous, tasteless, resinous; soluble in the alkalies with violet, and in ether with yellow color.

ACTION AND USES.—Of no value medicinally. Used in pharmacy for coloring preparations.

143. SENNA.—SENNA.

SENNA. *Ger.* SENNESBLÄTTER.

The dried leaflets of **Ca'ssia acutifo'lia** Delile and **C. angustifolia** Vahl.

BOTANICAL CHARACTERISTICS.—The acute-leaved senna, *C. acutifo'lia*, is a leafy shrub 2 to 5 feet high, bearing axillary racemes of yellow *flowers*. *Legume* flat, broadly oblong, very slightly curved inward, rounded at the extremities, terminating in an indurated and nearly obsolete style.

SOURCE.—**Alexandria senna,** exported by the way of Alexandria, is derived from *Ca'ssia acutifo'lia*, a species growing wild abundantly in upper Egypt, Nubia, etc. **India senna** (*C. angustifo'lia*) is obtained **chiefly in Arabia,** reaching western ports by way of Bombay and other Indian ports; sometimes called Mocha senna, as originally from that port. **The same plant in cultivation yields Tinnevelly senna.** The plant yields two annual crops, the best at the close of the rainy season (September), and the other during the dry season. Prepared for market by the natives, who carry it there on camels, where it is cleaned (garbled) and sold.

FIG. 76.—*A*, Alexandria senna. *B*, India senna.

DESCRIPTION OF DRUG.—Both the Alexandria and the India senna consist of leaflets, **a prominent distinction between the two being their size;** the former, the acutifolia, is described as follows: Lanceolate or ovate-lanceolate, 1.5 to 3 cm. long, 5 to 8 mm. broad; apex acute, mucronate; base unequal, acute; margin entire; upper surface light green, nearly glabrous, midrib sometimes depressed, veins of first order more or less prominent; under surface light grayish-green, midrib prominent, minutely pubescent, especially near the veins; petiole about 1 mm. long; texture coriaceous, fibrous; odor slight; taste somewhat bitter. *Powder:* Light green; non-secreting hairs 0.1 to 0.2 mm. long, one-celled, thick-walled, the wall of the upper part strongly cuticularized; calcium oxalate crystals rosette-shaped or in monoclinic prisms. The powder of Indian senna (*C. angustifolia*) is dark green and has relatively few non-secreting hairs. (For fuller particulars of the microscopical distinction of the two powders, see article by the author, "Amer. Jour. Pharm.," June, 1897, p. 298.) The India senna is by far a cleaner senna; senna should be free from stalks and other inert materials, and from Argel leaves (*Solenostem'ma ar'gel*, N. O. Asclepiadeæ), which are thick, even at the base, and one-veined.

Powder.—Light green. Characteristic elements: Stomata, roundish in outline in Alexandria, more elongated in India Senna. In simple powders the mere number of hairs will distinguish between the two sennas; the shape of the stomata will have to be examined; many of the elongated oval forms indicate the presence of India senna; unicellular hairs, abundant in Alexandria, but few or none in India senna. The leaves of Castanea dentata as an adulterant give a powder that turns blue with ammonio-ferric alum. T. S.

CONSTITUENTS.—The purgative action of senna depends upon a sulphuretted glucoside, **cathartic acid,** insoluble in alcohol, soluble in water, but rendered partially or wholly inert by prolonged evaporation

FIG. 77.—*Cassia acutifolia*—Branch showing flowers and fruit.

or boiling of its solution. Senna **also contains chrysophan,** phæoretin, sennacrol, and gluco-sennin, $C_{22}H_{18}O_8$; this latter is probably an emodin glueoside. The emodin is said to be identical with that found in Barbadoes and Cape Aloes. The principles giving the odor and taste to senna, also its griping action, are extracted by alcohol, somewhat affecting the cathartic action, however.

Preparation of Cathartic Acid.—Rhubarb or senna may be treated separately as follows: Moisten the drug with alcohol. Macerate 48 hours and percolate with strong alcohol till exhausted, to remove chrysophanic acid, resin, etc.

Exhaust the marc with 60 per cent. alcohol. Evaporate the percolate at 50° C. to syrup, with constant stirring. Precipitate extract with 85 per cent. alcohol and filter to remove gum. The filtrate, after evaporating to a syrupy consistence, is added to a large excess of absolute alcohol. The brown precipitate thus produced is spread on glass to dry. It is then in light, shining scales.

ACTION AND USES.—A prompt and efficient cathartic. Its griping action may be prevented by combining it with an aromatic and one of the alkaline salts, or, as before stated, by first extracting the griping principle with alcohol. Dose: 2 to 8 dr. (8 to 30 Gm.).

OFFICIAL PREPARATIONS.

Infusum Sennæ Compositum (6 per cent., with manna and Epsom salts, each, 12 per cent., and fennel 2 per cent.), ...Dose:	1 to 2½ fl. oz. (30 to 75 Cc.).
Syrupus Sennæ (25 per cent. of Fl'ext.),	1 to 4 fl. dr. (4 to 15 Cc.).
Fluidextractum Sennæ, ...	½ to 4 fl. dr. (2 to 15 Cc.).
Confectio Sennæ (10 per cent., with cassia fistula, tamarind, prune, fig, sugar, and oil of coriander), ...	1 to 3 dr. (4 to 12 Gm.).
Pulvis Glycyrrhizæ Compositus (18 per cent.), ...	1 to 2 dr. (4 to 8 Gm.).

144. **CASSIA MARILANDICA** Linné.—AMERICAN SENNA. (Leaflets.) Oblong-lanceolate, about 25 mm. (1 in.) in length, mucronate at the apex and uneven and short-stalked at base; lower surface lighter green than upper surface. They have a weaker odor and taste than senna, but have similar medicinal properties, their action depending upon the same principle, cathartic acid.

145. **MELILOTUS.**—SWEET CLOVER. The flowering tops of **Melilo'tus officina'lis** Willdenow. The small yellowish or white flowers are in a close, rounded raceme on an angular stem; leaves serrate, trifoliate; odor fragrant, honey-like; taste aromatic and bitter. They contain melilotol (a fragrant volatile oil), coumarin (the aromatic principle of tonka), cumaric acid, and melilotic (hydrocumaric) acid, having a honey-like odor. An infusion is used as a stimulant and antispasmodic in whooping-cough, but it is generally used as a local anodyne in poultices.

146. **TRIFOLIUM PRATENSE** Linné.—The flowering tops of this, our common red clover, are now being used quite extensively as an alterative; they are also deobstruent and sedative in whooping-cough.

146 a. **TRIFOLIUM REPENS.**—WHITE CLOVER. The tops are used in whooping-cough and other spasmodic affections, in the form of infusion.

147. **STYLOSANTHES ELATIOR** Swartz.—PENCIL FLOWER. This herb is much used in domestic practice as a uterine sedative and tonic. The fluidextract is not miscible with water. Dose of fluidextract: 10 to 20 ♍ (0.6 to 1.3 Cc.).

147 a. **GALEGA.**—GOAT'S RUE. The herb of **Galega officinalis** Linné. Europe. Recently introduced. An erect glabrous perennial, about three feet high. Leaves alternate, oddly pinnate, and stipulate; stipules lanceolate; leaflets smooth, lanceolate, and mucronate. Flowers in loose, axillary racemes longer than the leaves; blue, appearing in June or July. *Preparation:* Fluidextract. *Properties:* Vermifuge, nervous stimulant, galactagogue. In typhoid conditions diuretic and tonic. Dose: 15 to 20 minims.

148. SCOPARIUS.—Scoparius.

BROOM. *Ger.* GEMEINE BESENGINSTER.

The dried tops of **Cyti'sus scopa'rius** (Linné) Link.

BOTANICAL CHARACTERISTICS.—A shrub 2 to 3 feet high. *Leaves* minute ternate. The *leaflets* obovate-oblong, entire. *Flowers* bright yellow, large, axillary, with ten monadelphous stamens. *Pod* almost black, compressed, hairy along the sutures. *Seeds* numerous.

FIG. 78.—*Cytisus scoparius*—Flowering branch and pod.

HABITAT.—Europe and Asia.

DESCRIPTION OF DRUG.—**Thin, flexible, branched twigs,** pentangular and winged, nearly smooth, and of a dark greenish-brown color; as found in the market they are usually free from the small trifoliate leaves. Odor slight, stronger when bruised; taste **very bitter.**

Powder.—Greenish-brown. Characteristic elements: Sclerenchyma with bast fibers, long, thick-walled, associated with crystal fibers containing calcium oxalate prisms; ducts, spiral, annular, and reticulate; trichomes, non-glandular (0.5 to 0.7 μ in diam.), thick-walled, yellowish, one-celled; pollen, brownish; grains, oval.

CONSTITUENTS.—A neutral crystalline principle, **scoparin,** $C_{20}H_{20}O_{10} + 5H_2O$, to which the diuretic action is due, and the colorless, volatile, liquid alkaloid, **sparteine,** $C_{15}H_{26}N_2$, acting as a powerful cardiac tonic; this is oily, very bitter, soluble in alcohol, chloroform, and ether; it has been made official as the salt, sparteinæ sulphas. Prisms freely soluble in water. Oxidation products, such as oxysparteine, $C_{15}H_{24}N_2O$, produce an increase of heart activity, while dioxysparteine, $C_{15}H_{26}N_2O$, produces an inverse effect upon the heart. Sparteine has an aniline-like odor.

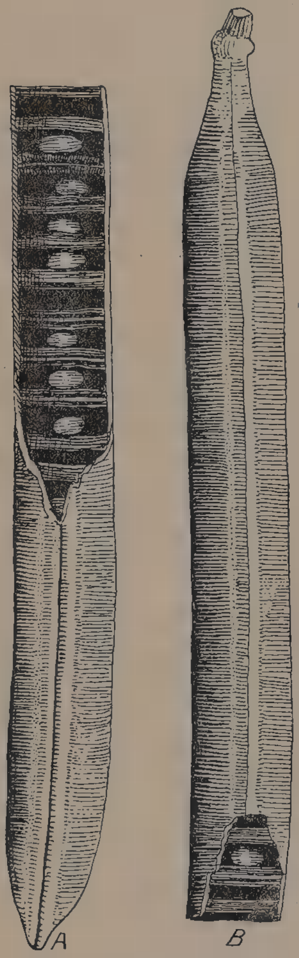

FIG. 79.—*Cassia fistula*, two-thirds natural size. *A*, Ventral view. *B*, Dorsal view.

Preparation of Scoparin.—Allow a concentrated decoction of broom-tops to gelatinize; express and purify the jelly-like mass by repeated solution in hot water, and finally in hot alcohol.

Preparation of Sparteine.—Extract plant with acidulated water and distil concentrated liquid with NaOH. A colorless oily liquid, forming crystalline salts. Sulphate official.

ACTION AND USES.—Scoparius is a reliable diuretic and laxative in small doses of 10 to 30 gr. (0.6 to 2 Gm.), and is an efficient remedy in dropsy. Dose of sparteinæ sulphas: $\frac{1}{8}$ to 1 gr. (0.0081 to 0.065 Gm.).

OFFICIAL PREPARATION.

Extractum Scoparii,
U.S.P., 1890.. Dose: 15 to 60 ♏ (1 to 4 Cc.).

149. CASSIA FISTULA.—CASSIA FISTULA.

PURGING CASSIA. *Ger.* PURGIERCASSIE.

The dried fruit of **Cas'sia fist'ula** Linné.

BOTANICAL CHARACTERISTICS.—Tree from 20 to 50 feet high, with showy *racemes*, 1 to 2 feet long, of bright yellow, fragrant *flowers*, followed by cylindrical pods of the same length. *Legume* woody, indehiscent.

HABITAT.—Upper Egypt and India; extensively cultivated throughout all tropical regions.

DESCRIPTION OF DRUG.—Cylindrical pods or legumes 450 to 600 mm. (18 to 24 in.) long and about 25 mm. (1 in.) in diameter, with a blackish-brown, woody pericarp; indehiscent, but with two smooth sutures or bands on opposite sides running the whole length of the

pod, and showing the union of the two valves. The dorsal band is marked with a fine ridge, while the ventral band is seemingly divided into two by a shallow, longitudinal groove. **The interior of the pod consists of numerous** (25 to 100) **transverse cells, each containing a single, flattish, glossy, red-brown seed, imbedded in a sweet, blackish-brown pulp**; odor prune-like.

CONSTITUENTS.—The pulp, which is the part used, consists mainly of sugar (about 60 per cent.), with mucilage, pectin, albuminoids, and organic salts.

ACTION AND USES.—A mild laxative, generally combined with other mixtures. Dose: 1 to 8 dr. (4 to 30 Gm.).

OFFICIAL PREPARATION.

Confectio Sennæ (16 per cent.), ...Dose: 1 to 3 dr. (4 to 12 Gm.).

150. **CERATONIA.**—ST. JOHN'S BREAD. The fruit of **Cerato'nia sil'iqua** Linné. *Habitat:* Southern Europe. Broad, flat pods, brown and glossy, divided into six to twelve transverse cells, in each of which is a sweet, black pulp having a single seed imbedded in it. This pulp is used as a laxative and demulcent, but chiefly as an ingredient in expectorant mixtures.

151. TAMARINDUS.—TAMARIND.

TAMARIND. *Ger* TAMARINDEN.

The preserved pulp of the fruit of **Tamarin'dus in'dica** Linné.

BOTANICAL CHARACTERISTICS.—The Indian date, as it is called in its native country, is a lofty tree (60 to 80 ft.) with crooked branches, and remarkable for its bright and elegant foliage. *Leaflets* 10 to 15 pairs, small, narrow, oblong, obtuse. *Flowers* in racemes, of a yellow color variegated with red. *Fruit* a broad legume, thickish, indehiscent, pulpy, ramified by strong fibers.

HABITAT.—India and Africa.

DESCRIPTION OF DRUG.—A **tough, reddish-brown mass,** made adhesive by the syrup in which the fruit is preserved. This preserved pulp **consists of a fibrous or stringy mucilaginous mass,** the thin membranous epicarp (the pericarp being removed), and numerous large, somewhat quadrangular, brown seeds, each inclosed in a tough membrane; inodorous; taste sweetish and acidulous.

CONSTITUENTS.—Tartaric acid and acid potassium tartrate, with traces of citric and malic acids. These organic salts amount to about 10 per cent.

ACTION AND USES.—Laxative and refrigerant. Dose: 1 to 8 dr. (4 to 30 Gm.).

OFFICIAL PREPARATION.

Confectio Sennæ (10 per cent.), ...Dose: 1 to 3 dr. (4 to 12 Gm.).

152. **DIPTERYX.**—Tonka Bean. The fruit of a large tree, **Dip'teryx odora'ta** Willdenow, growing in Guiana. Oblong, flattened, rounded at each end, 37 to 50 mm. (1½ to 2 in.) long; pericarp thin, wrinkled, of a dark brown color, somewhat glossy, and often covered with small, white crystals of coumarin; internally oily, pale brown; odor fragrant, similar to vanilla; taste aromatic and bitter. Its odor is due to the aromatic, crystalline principle **coumarin.** Used as a flavor, as an adulterant of vanilla, and to flavor cigars.

Fig. 80.—*Trigonella fœnum græcum*—Branch.

153. **FŒNUM GRÆCUM.**—Fenugreek. The seeds of **Trigonel'la fœnum græ'cum** Linné. *Habitat:* India and the Mediterranean Basin. Brownish or yellowish, rhomboid seeds, about 3 mm. (⅛ in.) in diameter, often wrinkled or distorted. They are divided into two equal lobes by a deep furrow running from the hilum on the sharper edge, diagonally across the sides. Odor peculiar, characteristic; taste mucilaginous and bitter. Used mostly as a demulcent in condition-powders.

154. PHYSOSTIGMA.—Physostigma.

CALABAR BEAN. *Ger.* CALABARBOHNE.

The ripe seed of **Physostig'ma veneno'sum** Balfour, yielding, by official assay, not less than 0.15 per cent. of ether-soluble alkaloids.

Botanical Characteristics.—A lofty, half-shrubby, twining plant, obtaining its name from its peculiar footed stigma. *Leaves* trifoliate, *leaflets* ovate. *Flowers* purplish-pink, in axillary racemes. *Legume* about 7 inches long.

Habitat.—Africa.

Description of Drug.—**About the size of a pecan nut,** oblong, somewhat flattened, and **kidney-shaped,** invested with a light to **deep chocolate-brown testa.** Along its entire convex edge there extends a prominent black furrow, bordered on each side by a reddish ridge, and traversed the entire length by the raphe as a little ridge in the center. This raphe is **terminated at one end by a small funnel-shaped depression, the micropyle.** Exalbuminous, embryo large, the cotyledons are concavo-convex, the concave surfaces inclosing a rather large cavity, thus enabling the bean to float upon water. Nearly odorless; taste bean-like, afterwards acrid. Spurious calabar beans have been called "cali beans" in European commerce, those occurring the most frequently belonging to the following species: *Entada scandens*, *E. gingalobium* D. C., *Mucuna urens* D. C., and seeds of oil palms, *Elæis Guineensis*. E. H. Holmes called attention to certain specimens of calabar beans of commerce bearing a close resemblance to the genuine beans. They were longer, of circular cross-section, and the hilum did not extend the full length of the bean. They also differ chemically, as upon touching the cotyledons with a solution of potassa a permanent yellow tint was produced, and upon treating the spurious article similarly a deep, almost orange, color is formed, turning to a greenish hue. It has been found that the ordinary test-reagents for alkaloids are so sensitive for physostigmine

Fig. 81.—Calabar Bean.

(eserine) that one one-millionth part of a gram may be recognized. The poisonous qualities reside in the seeds, especially in the cotyledons. It has been ascertained that the leaves and stems are not poisonous.

Powder.—Dark brown. Characteristic elements: Large starch grains; fat and colorless granular matter abundant; brownish palisade cells with coloring-matter. Seldom used as a powder.

$\frac{1}{2}$

FIG. 82.—*Physostigma venenosum*—Portion of plant and fruit.

CONSTITUENTS.—**Physostigmine,** $C_{15}H_{21}N_3O_2$ (also known as **eserine**), contracting the pupil of the eye; calabarine, a tetanizing principle, a derivative of physostigmine; eseridine, $C_{15}H_{23}N_3O_3$ (producing purgation); and physosterin, a neutral principle closely related to cholesterin. These principles are soluble in alcohol. Physostigmine is amorphous, tasteless, reddened by potassa, soda, and lime when exposed to the air, due to absorption of oxygen. The drug sometimes contains over 0.15 per cent. of the alkaloid Physostigmine.

Preparation of Physostigmine (*Eserine*).—Treat powdered drug (mixed with 1 per cent. tartaric acid) with water. Shake out coloring matter with ether, make aqueous solution alkaline with an alkaline bicarbonate, and shake out alkaloid with ether. Evaporate ethereal solution.

Preparation of Eseridine (*Calabarine*).—Precipitate the alkaloid from the liquid from which physostigmine has been separated by lead subacetate and ammonia; evaporate the filtrate, treat the residue with alcohol, precipitate with phosphotungstic acid, and decompose with baryta. It is converted into physostigmine by hydrolysis.

Preparation of Physosterin.—Exhaust beans with petroleum ether and evaporate solvent.

ACTION AND USES.—Spinal sedative; poison. Dose: 1 to 4 gr. (0.065 to 0.25 Gm.). Physostigmine is a myotic.

OFFICIAL PREPARATIONS.

Physostigminæ Salicylas,.. Dose:	$\frac{1}{120}$ to $\frac{1}{30}$ gr. (0.0005 to 0.00216 Gm.).
Physostigminæ Sulphas,...	$\frac{1}{120}$ to $\frac{1}{60}$ gr. (0.0005 to 0.0010 Gm.).
Extractum Physostigmatis,	$\frac{1}{10}$ to $\frac{1}{2}$ gr. (0.0064 to 0.0324 Gm.).
Tinctura Physostigmatis (10 per cent.), ...	10 to 40 ♍ (0.6 to 2.6 Cc.).

155. **MUCUNA.**—COWAGE, OR KIWACH, the Hindustan name, vulgarly corrupted into cow-itch. The hairs from the pods of **Mucu'na pru'riens** De Candolle, a high-climbing plant growing in tropical Africa, America, and India. These hairs are about 3 mm. ($\frac{1}{8}$ in.) long, stiff, brown-red, and readily penetrate the skin, causing violent itching. Detached from the pod (which forms an article of diet in India) by dipping it in honey and then scraping. An electuary is used in doses of a teaspoonful to a tablespoonful. Cowage acts as an **anthelmintic mechanically,** penetrating the bodies of the worms and thus irritating and dislodging them.

156. **ARAROBA.**—GOA POWDER. A mixture of neutral principles obtained from radial fissures in the wood of a Brazilian tree, **Andi'ra araro'ba** Aguiar. This powder is of a light yellow color, with a somewhat earthy appearance, turning dark brown or purplish on exposure; somewhat crystalline, rough, and mixed with pieces of wood-fiber; inodorous and very bitter. It consists chiefly of chrysarobin (Chrysarobinum, U. S.). Used externally, in ointments, in skin diseases caused by fungi.

157. ACACIA.—ACACIA.

GUM ARABIC. *Ger.* ARABISCHES GUMMI.

A gummy exudation from **Aca'cia sen'egal** Willdenow and of other species of Acacia.

BOTANICAL CHARACTERISTICS.—A small tree about 20 feet high, with a gray bark. *Leaves* bi-pinnate. *Flowers* pale yellow, in dense spikes. *Legumes* broad, three to four inches long.

HABITAT.—The acacia tree forms dense scrubby forests in the sandy regions watered by the Senegal, and in Abyssinia and Kordofan.

DESCRIPTION OF DRUG.—In roundish, brittle **tears or broken fragments about the size of a pea,** or larger, with an opaque appearance, due to the numerous fissures. Inodorous; **taste mucilaginous and insipid.** Soluble in water, forming a thick mucila-

ginous liquid; **insoluble in alcohol.** The aqueous solution has an acid reaction and yields gelatinous precipitates with subacetate of lead, ferric chloride, and concentrated solution of borax. Oxalates precipitate the calcium base. There are two kinds of "powdered acacia" on the market, the "granulated" and the "finely dusted." The former is more soluble and less liable to form lumps, and is, therefore, preferable for pharmaceutical purposes.

VARIETIES AND GRADES.—The Kordofan and Senegal gums are the product of *A. Senegal.* The former has been described above. Gum Senegal, deriving its name from the river Senegal, comes in larger tears than the former, varying in color between yellow and yellowish-brown, being less fissured and more transparent. As to the grades of gum, it may be said that the quality entering the market varies exceedingly in its solubility, viscosity of its mucilage, and its color. In the market the grades are designated by numbers, No. 1 being the best carefully selected tears, No. 2 the next best, and so on until several selections have been made, the remaining colored pieces containing impurities being termed "sorts"; but this term is sometimes applied to unsorted gum arabic, often consisting of a mixture of the lower grades. The terms "strong" and "weak" have been applied, designating the quantity of moisture, the strong being the drier and probably the most soluble; the weak being that which possibly swells in water, does not completely dissolve, and hence yields a relatively small percentage of mucilage.

Mesquite gum is obtained from *Prosopis juliflora*, found in Southwestern America and South America. Quite abundant in some portions of Texas and New Mexico. It occurs in colorless or amber-brown tears; resembles gum arabic somewhat in fissures, specific gravity, solubility, its behavior to nitric acid, and the amount of ash yielded upon incineration (2.1 to 3 per cent.). Its aqueous solution is not precipitated by subacetate of lead, ferric salts, or borax. Acetate of lead, with ammonia added subsequently, yields a gelatinous precipitate. These reactions, however, differ to some extent in different samples.

CONSTITUENTS.—**Arabic acid,** $C_{12}H_{22}O_{11}$, **combined with calcium, magnesium, and potassium,** to the presence of which its solubility is due; boiled with dilute acid it yields arabinose or arabin sugar. A solution of the gum is **unaffected by neutral lead acetate.** The gum contains about 14 per cent. of moisture and some sugar.

Preparation of Arabic Acid.—Obtained by adding alcohol to acidified (HCl) mucilage, and drying the precipitate. It yields arabinose in prismatic crystals when boiled with acids and possibly also galactose.

ACTION AND USES.—Demulcent. Used in pharmacy for suspending insoluble matters in water, as in emulsions, and as an excipient.

OFFICIAL PREPARATIONS.

Mucilago Acaciæ (34 per cent).
Syrupus Acaciæ (10 per cent. of acacia), Dose: 1 to 8 fl. dr. (4 to 30 Cc.).
Pulvis Cretæ Compositus (20 per cent.), used as an excipient.

158. TRAGACANTHA.—TRAGACANTH.

GUM TRAGACANTH. *Ger.* TRAGANTH.

A gummy exudation from **Astra'galus gum'mifer** Labillardiere, and from other species of Astragalus.

BOTANICAL CHARACTERISTICS.—A small, tangled, spiny bush of compact growth, the *petioles* being converted into long spines. *Flowers* yellow, in axillary clusters. *Legume* partially two-celled.

HABITAT.—Western Asia.

DESCRIPTION OF DRUG.—The flake tragacanth comes in transversely lined, **curved, and contorted bands,** somewhat resembling fragments of oyster shell, but **tough and horny;** color whitish or yellowish, **translucent.** Taste insipid, sometimes faintly bitterish; inodorous. It is difficult of pulverization, made less so, however, by the use of a warm mortar. It does not dissolve in water, but swells up and forms a thick, gelatinous mass.

VARIETIES.—Very narrow bands or strings variously coiled. Tragacanth in sorts—stratified or nodular, conical and subglobular pieces, more or less brown, often adulterated with the gum of the almond and plum trees.

CONSTITUENTS.—**Traganthin or bassorin,** $C_6H_{10}O_5$, constituting about 43 per cent., swelling up in water, but not dissolving; and **arabin,** the calcium salt of gummic acid, soluble in water, but not identical with the arabin or arabic acid of acacia.

ACTION AND USES.—Used as a demulcent, but rarely, however, on account of its insolubility. Chiefly used in pharmacy to give consistence to lozenges, etc.

OFFICIAL PREPARATION.

Mucilago Tragacanthæ (6 per cent.).

159. CATECHU.—CATECHU.

CUTCH. *Ger.* CATECHU.

An extract prepared from the heart-wood of **Aca'cia cat'echu** Linné (U. S. P 1890.) (See also **Gambir,** p. 194.)

BOTANICAL CHARACTERISTICS.—Small tree with straggling, thorny branches, and compact, dark red wood. *Leaves* bipinnate; *petiole* angular, with

prickles on its under side. *Flowers* pale yellow. *Legume* about three-seeded.

SOURCE.—The tree is common in most parts of India and Burmah, where the export of cutch forms, next to the sale of timber, the most important item of forest revenue. It abounds in the forests of tropical Eastern Africa, but in many places where the tree abounds it is only valued for its wood. In comparatively few regions is any extract manufactured. From *Acacia suma*, a nearly related species growing in Southern India, catechu is also made. The extract from these two species of acacia furnishes a variety of catechu, but a catechu formerly prescribed as *Catechu pallidum* (pale catechu), gambir, is official in the present Pharmacopœia and is described as follows:

GAMBIR.

GAMBIR. (CATECHU.)

An extract prepared from the leaves and twigs of **Ourouparia Gambir** (Hunter) Baillon (Fam. Rubiaceæ). (Replacing Catechu, U. S. P. 1890. See p. 193.)

Irregular masses of cubes about 25 mm. in diameter; externally reddish-brown, pale brownish-gray or light brown; fracture dull-earthy, friable, crystalline; inodorous, bitterish, very astringent with a sweetish after-taste.

Not less than 70 per cent. should be soluble in alcohol; the ash should not be more than 5 per cent., and starch should not be present.

CONSTITUENTS.—Mainly **catechu-tannic acid,** 45 to 55 per cent., which does not produce gallic acid on exposure to air as does the tannin of galls; it is turned blackish-green by ferric salts. Catechin is an interesting principle which, by dry distillation, yields pyrocatechin, or catechol, $C_6H_6O_2$, which, with ferric chloride, gives a dark green color by ammonia changing to violet.

Preparation of Catechin.—On allowing the decoction of catechu to stand several days, crude catechin is deposited. This deposit is purified to white silky needles by dissolving in dilute alcohol, washing with ether, and evaporating from hot aqueous solution. It has a sweetish taste, is precipitated by albumen, but not by gelatin.

ACTION AND USES.—A **powerful astringent** like kino. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Gambir Composita (5 per cent., with saigon cinnamon 2.5 per cent.), ... Dose: 15 to 60 ♏ (1 to 4 Cc.)
Trochisci Gambir (about 1 gr. in each troche), ... 1 or more.

160. KINO.—Kino.

KINO. *Ger.* KINO.

The inspissated juice of **Pterocar'pus marsu'pium** Roxburgh.

Botanical Characteristics.—A leafy tree 40 to 80 feet high, with reddish-brown bark. *Leaflets* 5 to 7, coriaceous, dark green, shining, 3 to 5 inches long. *Flowers* yellowish-white. *Legume* woody, indehiscent.

Source.—East Indies. We have several varieties other than the Malabar (East India), the official kind as described above—namely, African or Gambia kino (*P. erinaceus*), Palas or Bengal kino (*Butea frondosa*),

Fig. 83.—*Pterocarpus marsupium*—Branch.

Botany Bay or Eucalyptus kino (*E. amygdalina*), from Australia, and West Indian or Jamaica kino (*Coccoloba uvifera*). These all furnish extractives known as kino.

A new kind of kino from the juice of the bark of several kinds of Asiatic Myristica has been noticed, differing from the Malabar by containing, in the crude state, calcium tartrate. By this characteristic

it may easily be distinguished from the official and other kinos of the market.

Description of Drug.—Small, **dark reddish-brown, shining, angular fragments,** much lighter and nearly transparent in thin layers. Adheres to the teeth when chewed, and colors the saliva a deep red; odorless; taste sweetish and **astringent.** The powder is of a brownish-red color.

Constituents.—Kino-tannic acid (colored black-green by ferric salts, in neutral solution; violet by ferrous salts), kinoin, neutral crystalline prisms, pyrocatechin, kino-red, pectin, and ash.

Preparation of Kinoin.—Boil kino with dilute HCl and agitate clear solution with ether. Evaporate off the ether. Heating this to 266° F., an insoluble amorphous kino-red is obtained.

Pyrocatechin results from the dry distillation of kino, or is obtained by treating kino with ether.

Action and Uses.—A powerful astringent. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

Official Preparation.

Tinctura Kino (5 per cent.),...........Dose: 1 to 2 fl. dr. (4 to 8 Cc.).

161. COPAIBA.—Copaiba.

BALSAM COPAIBA. *Ger.* COPAIBA-BALSAM

The oleoresin of **Copai'ba langs'dorffii*** O. Kuntze, and of other species of Copaiba.

Botanical Characteristics.—Lofty forest trees, natives of Central America, bearing alternate, pinnate leaves. The wood of the trees is *replete with oleoresin,* sometimes even to bursting.

Source and Collection.—This oleoresin is derived from several species of copaiba, as *C. officinalis* (Carthagena), *C. langsdorffii* (Sao Paulo), *C. multifuga* (Para). These furnish the several commercial varieties. Obtained by making large augur holes, square or wedge-shaped boxes, into the center of the trunk, where the oleoresin collects. Sometimes these openings are closed or sealed with wax, and often the pressure from the high liquid column is said to burst the trunk with a very loud report. A tree may yield from ten to twelve gallons.

If 4 fluidrams of the above varieties of copaiba be mixed with 1½ fluidrams of aqua ammonia and shaken in a test-tube, the mixture will be clear, but milky if more alkali or fixed oil be present. Maracaibo (Colombia copaiba) is thicker, darker, not always clear.

* Sometimes written, incorrectly, lansdorffii (Lloyd).

It solidifies, however, with magnesia and contains from 20 to 40 per cent. of the volatile oil.

DESCRIPTION OF DRUG.—A more or less viscid, yellow or light brown, transparent liquid, of about the consistence of olive oil; specific gravity, 0.950 to 0.955 at 25° C. (77° Fahr.); it becomes thicker and darker with age, the volatilization and the oxidation of the volatile

FIG. 84.—*Copaiba langsdorffii*—Branch.

oil leaving a greater proportion of the soft resin. Odor peculiar, aromatic; taste bitter, acrid, and nauseous.

Para copaiba is a pale, limpid liquid containing from 60 to 90 per cent. of volatile oil. Maranham and Rio Janeiro copaiba are of the consistence of olive oil, and contain a somewhat smaller proportion of volatile oil—40 to 60 per cent. Maracaibo copaiba is dark yellow

or brownish, thick, somewhat turbid. It contains from 20 to 40 per cent. of oil of copaiba.

CONSTITUENTS.—**Volatile oil,** upon which its value mostly depends; a bitter principle, **and two resins, copaibic acid,** $C_{20}H_{30}O_2$ (soluble in ammonia and absolute alcohol), and a viscid, non-crystalline resin. Para copaiba contains oxycopaivic acid, $C_2H_{28}O_3$; Maracaibo copaiba, metacopaivic acid, $C_{22}H_{34}O_4$. Copaiba contains no benzoic nor cinnamic acids, hence the term balsam is a misnomer.

Preparation of Copaibic Acid.—Mix nine parts of copaiba and two parts of ammonia (sp. gr. 0.95); lower the temperature to 10° C.; crystals of copaibic acid are then obtained, which agree with abietic acid in composition, but not in properties.

ACTION AND USES.—Stimulant, diuretic, laxative. Its principal action, however, is on mucous membranes. Dose: 15 ♏ (1 Cc.), in emulsion.

OFFICIAL PREPARATION.

Massa copaibæ (U. S. P. 1890) (94 per cent.; Magnesia, 6 per cent.), ...Dose: 10 to 30 gr. (0.6 to 2 Gm.).

161 a. **OLEUM COPAIBÆ,** U. S.—OIL OF COPAIBA. A volatile oil distilled from copaiba. A pale yellowish liquid of an aromatic, bitterish taste, and having the general properties of the oleoresin. It is a pure hydrocarbon having the formula $C_{20}H_{32}$. Dose: 5 to 15 ♏ (0.3 to 1 Cc.), in emulsion.

162. **PONGAMIA OIL.**—KURUNG OIL. A deep yellow, or reddish-brown, fixed oil expressed from the seeds of an East Indian tree, **Ponga'mia gla'bra** Ventenat. It is used by the natives as a local application in skin diseases and rheumatism; especially recommended in pityriasis versicolor, and other cutaneous diseases due to fungous growth.

163. **COPAL.**—GUM COPAL. A resin found as a fossil in Zanzibar, or exuding from various species and genera of trees of the natural order **Leguminosæ,** growing in South America, West Indies, and Africa. Yellowish or brownish, irregular masses, often with a wrinkled surface; breaks with a glossy conchoidal fracture; odorless and tasteless. Used in making varnishes.

164. BALSAMUM PERUVIANUM.—BALSAM OF PERU.

BALSAM OF PERU. *Ger.* PERUVIANISCHER BALSAM.

A balsam exuded from the bruised trunk of **Tolui'fera perei'ræ** Baillon.

BOTANICAL CHARACTERISTICS.—A leafy tree, with wood containing a liquid balsam. *Leaves* imparipinnate; *leaflets* 5 to 11, alternate. *Racemes* 6 to 7 inches long. *Fruit* a one-celled, one-seeded pod about 3¼ inches long; *mesocarp* fibrous, the inner part with receptacles of oleoresin.

SOURCE AND COLLECTION.—This valuable tree grows in the wild forests of San Salvador, singly or in groups. The trees, owned by individ-

uals, are carefully guarded. The balsam is collected by loosening the bark with a blunt mallet for some distance in four alternate sections so as not to kill the tree. The loosened bark soon splits; it is set on fire and charred, leaving the wood bare. Pockets thus made are covered with rags to absorb the exuding balsam. These, when saturated, are thrown into boiling water, as a means of separating the balsam, which collects at the bottom of the vessel. The annual yield per tree is about twenty pounds. The fruit yields by expression a white balsam (balsam blanco, white Peru balsam), having a tonka-

FIG. 85.—*Toluifera pereiræ*—Flowering branch and fruit.

like odor, which contains a crystallizable resin. The name Myroxylon, as sometimes applied to the balsam, suggests the fact that for a long time it was supposed to be derived from a species of Myroxylon (*M. peruiferum*).

DESCRIPTION OF DRUG.—A brownish-black, oleoresinous, non-viscous liquid, transparent in thin layers, and, by transmitted light, a bright red-brown; heavier than water; odor balsamic and vanilla-like; taste warm, bitterish, afterward acrid.

CONSTITUENTS.—Benzoic and cinnamic acid, cinnamein (the cinnamate

of benzyl alcohol) constituting the greater part, about 60 per cent.; resin 32 per cent., and small quantities of benzyl alcohol, $C_6H_5CH_2$-CH_2OH; benzylic benzoate, $C_7H_5(C_7H_7)O_2$; stilbene, $C_{14}H_{12}$; styrol, C_8H_8; styracin; toluol, C_7H_8.

ACTION AND USES.—Stimulant, expectorant, and stomachic. Externally in ointment. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

165. BALSAMUM TOLUTANUM.—BALSAM OF TOLU.

BALSAM OF TOLU. *Ger.* TOLUBALSAM.

A balsam exuding from incisions in the trunk of **Tolui'fera Balsamum** Linné.

BOTANICAL CHARACTERISTICS.—A lofty evergreen tree with warty branches; the wood contains a liquid balsam, which exudes when incisions are made.

FIG. 86.—*Toluifera balsamum*—Branch and fruit.

Leaflets 7 to 8, ovate-oblong. *Legume* indehiscent, with winged expansions and a winged stalk; very broad at apex.

HABITAT.—Venezuela and New Granada.

COLLECTION.—The balsam is obtained by making V-shaped incisions

through the bark and collecting the exudate in small cups or calabashes. It is imported from Venezuela in tins holding from ten to twenty-five pounds. This tapping of the tree continues for eight months, causing the tree to become partially exhausted, showing itself in the lessened foliage. A spurious article has been found on the market. It has a soft consistence, is very sticky, especially when chewed, and under the microscope shows only an occasional crystal. On distilling a portion of this balsam with water, it was observed to contain more of a fragrant volatile oil and less cinnamic acid than the genuine drug.

Description of Drug.—A very viscid, yellowish-brown semi-solid, with a sweet, fragrant odor, and feebly aromatic taste. Long kept, it gradually hardens into a more or less solid mass, which is brittle in the cold. Soluble in volatile oils, alcohol, chloroform, glacial acetic acid, and solution of potassa. Readily fusible, and burns with an aromatic odor.

Constituents.—A volatile oil (chiefly toluene, $C_{10}H_{16}$), a resin, free acids (cinnamic and benzoic), and benzylic ethers of these, principally of the former. If a thin layer of the balsam be viewed under the microscope, numerous crystals of the free cinnamic acid are seen.

Action and Uses.—Stimulant expectorant, similar in action but weaker than balsam of Peru. The syrup is used as an agreeable basis for cough mixtures. Dose of the balsam: 8 to 30 ♏ (0.5 to 2 Cc.).

Official Preparations.

Syrupus Tolutanus (5 per cent. of tr.), . . Dose:	2 to 6 fl. dr. (8 to 24 Cc.).
Tinctura Tolutani (20 per cent.), ...	½ to 2 fl. dr. (2 to 8 Cc.).
Tinctura Benzoini Composita (4 per cent.), ...	15 to 60 ♏ (1 to 4 Cc.)

ROSACEÆ.—Rose Family.

Herbs, shrubs, or trees, with pinnate, palmate, or simple, alternate *leaves*. *Flowers* regular, *sepals* usually 5, united *petals* 5, perigynous; *stamens* numerous, distinct, perigynous; *pistils* 1 to many. The different tribes are characterized by the fruit—a drupe in Pruneæ, follicles in Spirææ, druples in Rubeæ, dry akenes in Potentilleæ and Poterieæ, bony akenes in Roseæ, and pomes in Pomeæ. Except in the seeds of the drupe-fruits, which develop the poison hydrocyanic acid, this order is destitute of noxious qualities.

Synopsis of Drugs from the Rosaceæ.

A. *Barks.*
PRUNUS VIRGINIANA, 166.
Choke Cherry, 167.
Malus, 170.
RUBUS, 180.
QUILLAJA, 175.

B. *Seeds.*
AMYGDALA AMARA, 172.
AMYGDALA DULCIS, 173.
Cydonium, 171.

C. *Fruits.*
PRUNUM, 168.
Rubus Idæus, 181.
Cratægus, 182.

D. *Leaves.*
Persica, 169.
Laurocerasus, 183.
Fragaria, 184.
E. *Flowers and Petals.*
ROSA GALLICA, 176.
Rosa Centifolia, 177.
CUSSO, 185.
F. *Rhizomes.*
Tormentilla, 186.
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G. *Herbs.*
Agrimonia, 190.
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H. *Volatile Oils.*
OLEUM ROSÆ, 179.
OLEUM AMYGDALÆ AMARÆ, 172 a.
I. *Fixed Oils.*
OLEUM AMYGDALÆ EXPRESSUM, 174.

FIG. 87.—*Prunus serotina*—Branch.

166. PRUNUS VIRGINIANA.—WILD CHERRY.

WILD CHERRY BARK. *Ger.* WILDKIRSCHENRINDE.

The bark of **Pru'nus sero'tina** Ehrhart, collected in autumn and carefully dried and preserved.

BOTANICAL CHARACTERISTICS.—A large forest tree. *Leaves* oval-oblong or lance-oblong, brilliant green, smooth on both sides, unequally serrate; *flowers* white, in racemes; *drupes* purplish-black and shining; bitter.

SOURCE.—United States and Canada. Although the name *Prunus vir-*

giniana has been held as the official and medicinal name, the botanical name is *P. serotina*. This leads to confusion among botanists, who strongly urge the discontinuance of the above official title. *Prunus virginiana* is the botanical name of the common choke cherry, not of the black wild cherry. *Prunus Pennsylvanica*, the wild red cherry, growing in rocky woods and along the lake shores, is frequently mistaken for the *P. serotina*.

DESCRIPTION OF DRUG.—About 2 mm. ($\frac{1}{12}$ in.) or more in thickness, curved or flat. The newer bark is covered with a smooth, **greenish periderm,** but bark collected from the older parts usually has the corky layer removed, leaving a rough, **rust-brown surface; inner surface lighter colored,** finely striate; fracture granular. Almost inodorous, but **emits the characteristic odor of bitter almonds when moistened;** taste astringent, aromatic, and bitter, at the last bitter almond-like.

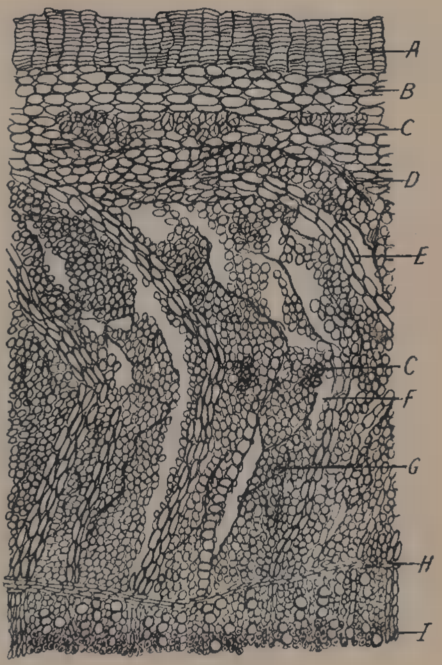

FIG. 88.—Cross-section of bark of stem of *Prunus Virginiana* (*P. serotina*). *A*. Cork. *B*. Middle or green layer of bark. *C*. Clusters of stone cells. *D*. Compressed sieve tissue. *E*. Medullary ray. *F*. Fissure between medullary ray and bast. *G*. Bast tissue. *H*. Cambium zone. *I*. Ducts in mature wood.

STRUCTURE.—Beneath the corky layer are found numerous clusters of stone cells, forming an interrupted zone. Just beneath this layer the medullary rays, which in the whole bark are wavy, terminate very obliquely. Between the medullary rays are found masses of stone cells and more elongated bast fibers.

The bark of the root is thought to be the most active, but that of the whole tree is collected indiscriminately.

RELATIVE VALUE OF THE OLD AND NEW BARK.—Experiments by Dohme and by Stevens have been made to decide whether the green bark is richer in hydrocyanic acid than the older, thick, brown bark. The results of the experiments of these gentlemen are somewhat contradictory. Dohme obtains 0.216 and 0.183 per cent. of HCN respectively, while the older bark assays 0.167 and 0.159 per cent. Stevens found in the older bark 0.335 per cent., while the younger assayed only 0.25 per cent. It is probably safe to say that the older thick bark is not so unworthy of recognition as some believe.

Powder.—Reddish-brown. Characteristic elements: Seldom dispensed as powder. The powder of the wild cherry bark is abundant in aggregate and prismatic crystals of calcium oxalate found in the parenchyma cells. Schneider calls attention to the bark of the choke cherry as differing from wild cherry in the absence of sclerenchyma cells, etc.

CONSTITUENTS.—Tannin, a bitter glucoside, resin, starch, etc. The **volatile oil and hydrocyanic acid,** to which the sedative action is due, do not preexist in the bark, but, as in the bitter almond, are formed by the action on amygdalin, in the presence of water, of a ferment analogous to, if not identical with, emulsin; **the action of this ferment is destroyed at a boiling temperature,** and therefore heat should never be used in making preparations of this bark.

ACTION AND USES.—Tonic and sedative. The syrup forms the basis of many of the cough syrups. Dose: 30 to 60 gr. (2 to 4 Gm.).

OFFICIAL PREPARATIONS.

Infusum Pruni Virginianæ (4 per cent., made with cold water), ...	Dose, 1 to 4 fl. oz. (30 to 120 Cc.).
Syrupus Pruni Virginianæ (15 per cent.), ...	1 to 4 fl. dr. (4 to 15 Cc.).
Fluidextractum Pruni Virginianæ, ..	30 to 60 ♏ (2 to 4 Cc.).

167. **CHOKE CHERRY.**—The bark of **Pru'nus virginia'na** Linné, a small tree growing in the Northern and Western States. Tonic and antiperiodic.

168. PRUNUM.—PRUNE.

PRUNE. *Ger.* PFLAUMEN.

The partly dried ripe fruit of **Pru'nus domes'tica** Linné.

BOTANICAL CHARACTERISTICS.—The French variety, or *Juliana*, the principal commercial prune, bears ovate-oblong, deep-purple *drupes*, not depressed at the insertion of the stalk, and with a scarcely visible suture and no furrow; pulp greenish and rather austere. The tree is small, with smooth branches and elliptical *leaves; flower-buds* formed of one or two flowers; *petals* white, oblong-ovate.

HABITAT.—Western Asia; cultivated in temperate regions. Most of the prunes come from France, the best from Bordeaux.

DESCRIPTION OF DRUG.—Dried, shriveled, oblong, almost globular, about 30 mm. ($1\frac{1}{5}$ in.) long; externally brownish-black. The sarcocarp (the medicinal portion) consists of a brownish-yellow pulp having a sweet, acidulous taste, and surrounds a single stone (putamen), which is very hard, smooth or ridged, and incloses a white, bitter seed.

CONSTITUENTS.—Sugar 12 to 25 per cent., pectin, malic acid, and salts. The seeds contain fixed oil, amygdalin, and emulsin.

Preparation of Amygdalin.—Obtained by solvent action of boiling alcohol upon the "oil cake," evaporating off alcohol, fermenting residue by yeast, and precipitating amygdalin and gum. Boiling alcohol takes up the principle which is deposited on cooling.

ACTION AND USES.—Laxative and nutrient, as an article of food or in laxative confections.

OFFICIAL PREPARATION.

Confectio Sennæ (7 per cent.), ...Dose: 1 to 3 dr. (4 to 12 Gm.).

FIG. 89.—*Prunus domestica*—Fruiting branch and flowering branch.

169. **PERSICA.**—PEACH LEAVES. From **Pru'nus per'sica** Linné. Mild sedative, generally administered in infusion. Dose: 15 to 30 gr. (1 to 2 Gm.).

170. **MALUS.**—APPLE TREE. The bark of **Pyr'us ma'lus** Linné. Tonic and febrifuge. Dose of fluidextract: 15 to 60 ♏ (1 to 4 Cc.).

171. **CYDONIUM.**—QUINCE SEED. **Pyr'us cydo'nia** Linné. *Habitat:* Western Asia; cultivated. About 6 mm. (¼ in.) long, ovate, somewhat triangularly compressed, with the hilum near the pointed end; testa dark brown, covered with a thin, mucilaginous membrane or epithelium, causing the seeds to adhere in masses. The two cotyledons are thick and oily, veined, with a short conical radicle. Taste and odor of the embryo like bitter almonds, of the unbroken seed mucilaginous and insipid. The testa contains a large amount of mucilage; the embryo, fixed oil. A decoction is often used as a demulcent, and as an addition to eye-lotions.

172. AMYGDALA AMARA.—Bitter Almond.

BITTER ALMOND. *Ger.* BITTERE MANDELN.

The ripe seed of **Pru′nus Amyg′dalus,** var. **Amara,** De Candolle.

Botanical Characteristics.—A small tree, 15 to 20 feet high, with lanceolate, glandular serrate *leaves,* with the petiole beset with glands. *Flowers* solitary, pinkish, the *style* equal in length to the stamens. *Seed* bitter.

Source.—The almond tree is considered to be a native of Morocco, Syria, Turkey, and Persia; it is doubtfully wild in Sicily, Greece, and Anatolia, and is cultivated throughout temperate Europe, includ-

Fig. 90.—*Prunus amygdalus*—Branch, flower, and fruit.

ing England, where it ripens its fruit in the south only. It has been unsuccessfully cultivated in the United States.

Description of Drug.—Oblong-ovate, flattened, about 25 mm. (1 in.) long; testa cinnamon-brown, scurfy, **marked with numerous longitudinal lines** running from a broad scar (chalaza) at the broad end, to the hilum on the pointed end. The embryo is white and oily,

and consists of two plano-convex cotyledons, at the pointed end of which there is a short radicle. Inodorous; bitter. When deprived of their testa by dipping in warm water and rubbing (blanched almonds), and triturated with water, a milk-white emulsion is formed, which faintly emits the odor of hydrocyanic acid. The development of this acid is due to the fact that amygdalin is decomposed by the ferment emulsin in the presence of water, yielding, besides the volatile oil and this acid, glucose.

CONSTITUENTS.—Fixed oil 45 per cent. and **amygdalin,** $C_{20}H_{27}NO_{11}$, a crystalline glucoside, having a sweetish-bitter taste, and soluble in water and hot alcohol; by the action of **emulsin,** a ferment existing in the seeds, **in the presence of water,** this glucoside splits up into glucose, hydrocyanic acid, and benzaldehyde, C_7H_6O (oil of bitter almonds). The investigation of this reaction first disclosed the existence and properties of the now numerous class—glucosides.

ACTION AND USES.—Sedative. From the seed is extracted the fixed oil (173) by expression, and from the residue the volatile oil (172 a) by distillation.

OFFICIAL PREPARATION.

Syrupus Amygdalæ (Spirit of Bitter Almond 1 per cent.), ...Dose: 2 to 4 fl. dr. (8 to 15 Cc.).

172 a. **OLEUM AMYGDALÆ AMARÆ,** U. S.—OIL OF BITTER ALMOND. A pale yellowish volatile oil obtained by macerating in water the residue left from bitter almonds after the fixed oil has been expressed, and distilling. It has a bitter, acrid taste, and a **strong odor of hydrocyanic acid.** It consists chiefly of benzoic aldehyde, to the oxidation of which is due the sediment, benzoic acid, thrown down on long exposure to air. Sedative. Dose: $\frac{1}{4}$ to 1 ♏ (0.0164 to 0.0650 Cc.), in emulsion.

OFFICIAL PREPARATIONS.

Aqua Amygdalæ Amaræ (0.1 per cent.),...Dose: $\frac{1}{2}$ to 2 fl.dr. (2 to 8 Cc.).
Spiritus Amygdalæ Amaræ (1 per cent.), · 5 ♏ (0.3 Cc.).

173. AMYGDALA DULCIS.—SWEET ALMOND.

SWEET ALMOND. *Ger.* SÜSSE MANDELN.

The ripe seed of **Pru'nus Amyg'dalus,** var. Dulcis, De Candolle.

BOTANICAL CHARACTERISTICS.—Like Amygdala Amara, except that the *style* is much longer than the *stamens*, and the *seed* is sweet.

SOURCE.—Western Asia and Barbary; extensively cultivated in Southern Europe, Spain and Southern France chiefly supplying the market.

DESCRIPTION OF DRUG.—Closely resembles the bitter almond, but is somewhat larger, with more convex sides, and has a **bland, sweetish taste,** free from rancidity. When triturated with water, it forms a milk-white emulsion, free from the odor of hydrocyanic acid.

CONSTITUENTS.—Fixed oil from 50 to 55 per cent., nitrogenous compounds 25 per cent. (**myrosin, vitellin, conglutin**) precipitated by acetic acid, **emulsin,** mucilage, and sugar amounting to about 6 per cent.

ACTION AND USES.—Nutrient and demulcent; being free from starch, sweet almonds are often used as a diet in diabetes.

OFFICIAL PREPARATIONS.

Emulsum Amygdalæ (6 per cent.),...	Dose: 2 to 8 fl. oz. (60 to 240 Cc.).
Syrupus Amygdalæ (14 per cent. U. S. P., 1890),........................	2 to 4 fl. dr. (8 to 15 Cc.).

174. OLEUM AMYGDALÆ EXPRESSUM.—EXPRESSED OIL OF ALMOND.

ALMOND OIL. *Ger* MANDELOEL.

A fixed oil expressed from Bitter or Sweet Almond.

DESCRIPTION.—A thin, clear, colorless or straw-colored liquid, with a mild, sweet taste and slight odor.

CONSTITUENTS.—Chiefly olein, with a slight quantity of palmitin.

ACTION AND USES.—Lenitive in pulmonary affections, in the form of emulsion. Dose: 1 to 4 fl. dr. (4 to 15 Cc.).

OFFICIAL PREPARATION.

Unguentum Aquæ Rosæ (56 per cent., with spermaceti, white wax, stronger rose-water, and borax).

175. QUILLAJA.—QUILLAJA.

SOAPBARK. *Ger*. SEIFENRINDE.

The dried bark derived of the periderm of **Quilla'ja sapona'ria** Molina.

BOTANICAL CHARACTERISTICS.—Tree of moderate size, with oval or oblong *leaves*, which are entire or nearly so. *Flowers* monœcious. *Fruit* a follicle, many seeded.

HABITAT.—Peru and Chili; cultivated in Hindustan.

DESCRIPTION OF DRUG.—In rather thick, flattish pieces of various sizes, deprived of the corky layer; outer surface brownish-white, sometimes with patches of the reddish-brown cork adhering; when held up to the light it shows **numerous glistening crystals** of calcium oxalate, which are scattered throughout the tissue. Fracture tough and

fibrous, a **transverse section showing a checkered arrangement** of pale brown bast fibers imbedded in the white wood. Odorless; taste persistently **acrid.** The powder is sternutatory. The powder of quillaja has been suspected as an adulterant of senega. It is not at all difficult to detect its presence in such admixtures, as in quillaja powder there are found elements not at all represented in senega. In quillaja there is a considerable amount of sclerotic tissue, numerous bast fibers, and prismatic crystals of calcium oxalate. Any and all of these clearly mark the powder of quillaja, and would at once betray its presence in the powder of senega.

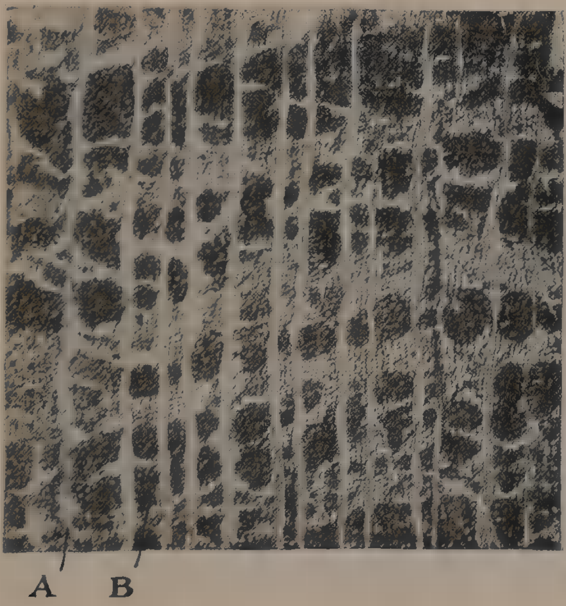

FIG. 91.—Quillaja—Cross-section of bark. (25 diam.) A, Medullary ray. B, Bast fibers and stone cells. (Photomicrograph.)

Powder.—Grayish. Inner parenchyma of cortex colorless (15 to 25 μ by 50 to 150 μ in diam.), mostly with large, long prisms of calcium oxalate; parenchyma of cortex with starch (3 to 10 μ in diam.); sclerenchyma with bast fibers (20 to 30 μ in diam.), thick-walled, porous, occasionally branched; stone cells (50 to 150 μ in diam.).

CONSTITUENTS.—Its irritant property is due to the presence of **saponin,** $C_{19}H_{30}O_{10}$, a mixture of the two glucosides, **quillaiac acid** and **sapotoxin.**

Preparation of Saponin.—Exhaust quillaja with hot alcohol, from which it separates upon cooling. Saponin is regarded as a mixture of two glucosides, quillaiac acid and sapotoxin.

ACTION AND USES.—Containing about the same principles as senega, it

has been recommended as a substitute for that drug as an expectorant in pulmonary affections. Dose: 15 to 30 gr. (1 to 2 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Quillajæ.
Tinctura Quillajæ (20 per cent.), ...Dose: 1 to 2 fl. dr. (4 to 8 Cc.).

FIG. 92.—*Quillaja saponaria*—Branch.

176. ROSA GALLICA.—RED ROSE.

RED ROSE. *Ger*. ESSIGROSENBLÄTTER.

The dried petals of **Ro′sa gal′lica** Linné, collected before expanding.

BOTANICAL CHARACTERISTICS.—A dwarfish bush, with odd-pinnate *leaves* and adnate *stipules; leaflets* elliptical, rugose. *Flowers* large, red; *stamens* many. *Carpels* several, becoming bony akenes in *fruit*. Receptacle urn-shaped, with *styles* rising from inner surface.

HABITAT.—Asia and Europe; cultivated.

DESCRIPTION OF DRUG.—The buds are collected before expanding, the

petals being loosely imbricated in the form of cones, or separate and crumpled. They are roundish-obovate, with a dark red, velvety appearance, which they retain after drying, during which process the fresh petals lose 90 per cent. of their weight; claws yellow; odor fragrant; taste bitter and astringent.

CONSTITUENTS.—The astringency is due principally to **quercitrin,** with which their color is also doubtless connected. They contain some tannin, fat, and volatile oil. Boiling water extracts their virtues.

ACTION AND USES.—Mild tonic and astringent; chiefly employed as a vehicle for tonic and astringent preparations. Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Rosæ, ...	Dose: 15 to 60 ♍ (1 to 4 Cc.).
Syrupus Rosæ (12.5 per cent.),.........	1 fl. dr. (4 Cc.).
Mel Rosæ (12 per cent.).	
Confectio Rosæ (8 per cent., with sugar, honey, and rose-water).	
Pilulæ Aloes et Mastiches (.03 Gm.), ...	1 to 5 pills.

177. **ROSA CENTIFOLIA.**—PALE ROSE. HUNDRED-LEAVED OR CABBAGE ROSE. The petals of **Ro'sa centifo'lia** Linné. Off. U. S. P. 1890. The full-blown flower is picked off just below the calyx, and the petals separated. They are a beautiful pink when fresh, dull brown when dry; thin and delicate, roundish-obovate, sometimes obcordate, with a fragrant odor, and a bitter, faintly astringent taste. They may be preserved fresh for a considerable time by packing them in half their weight of common salt. These petals were formerly used in making the compound syrup of sarsaparilla, but wisely have been dropped as one of the ingredients. *Constituents:* Malic and tartaric acids, tannin, etc. Their odor depends upon a volatile oil existing in small quantity, about 0.04 per cent. Seldom, if ever, used medicinally. In pharmacy used principally for preparing rose-water.

178. **ROSA CANINA.**—HIPS. DOG ROSE. The fruit of **Ro'sa cani'na** Linné, common in Europe. Ovoid, or pitcher-shaped, about 18 mm. ($\frac{3}{4}$ in.) long, with a smooth, shining, red surface. It consists of the ripened fleshy calyx, surmounted by the five calyx teeth; its cavity is hairy inside, and contains numerous hard, hairy akenes, but these akenes and hairs are removed before the hips are used. Taste acidulous, slightly astringent, due to the malic and citric acids and slight quantity of tannin contained; odorless. Refrigerant, mild astringent, and diuretic. Confection of hips is a familiar preparation abroad.

179. OLEUM ROSÆ.—OIL OF ROSE.

ATTAR OF ROSES. *Ger.* ROSENOEL.

A volatile oil distilled from the fresh flowers of **Ro'sa damasce'na** Miller.

BOTANICAL CHARACTERISTICS.—From cultivated *flowers* growing on bushes about 6 feet high. Reliable information regarding this species of rose is difficult to obtain. Some authors claim the flower to be "a permanently uniform variety of *Ro'sa centifo'lia.*"

SOURCE.—District of Kisanlik, in southern slope of the Balkans.

DESCRIPTION.—A pale yellow liquid having a specific gravity of 0.87, an agreeable rose odor, and sweetish taste. It solidifies between 16° and 21° C. into a transparent solid, containing numerous slender, iridescent crystals of the stearopten, which float on the surface when the solid is melted, as by the heat of the hand. (See Tests in U. S. P. for saponification value.)

CONSTITUENTS.—It consists of two parts, one of which is fragrant and the other comparatively inodorous. The fragrant principles are mainly geraniol and citronellol; the other a white crystalline stearopten, $C_{16}H_{34}$, melting at 36.5° to 38° C.

ACTION AND USES.—Used as a perfume for ointments, etc.

FIG. 93.—*Rubus villosus*—Branch and fruit.

180. RUBUS.—RUBUS.

BLACKBERRY ROOT. *Ger*. BROMBEERRINDE.

The dried bark of the rhizome of **Ru'bus villo'sus** Aiton, **Rubus Nigrobaccus** Bailey, and **Rubus cuneifolius** Pursh.

BOTANICAL CHARACTERISTICS.—A low shrub, extensively trailing, with scattered prickles. *Leaflets* usually 3, ovate-lanceolate, serrate. *Flowers* in

racemes, with leaf-like bracts; *pistils* numerous, becoming drupels in fruit. *Fruit* aggregate.

HABITAT.—North America.

DESCRIPTION OF DRUG.—In thin, tough, pliable bands 1 to 2 mm. ($\frac{1}{25}$ to $\frac{1}{12}$ in.) thick, having a blackish-gray outer surface, longitudinally wrinkled, and a pale brown inner surface; bast layers tangential, the fibers easily removed. Odorless; taste astringent and somewhat bitter. The root of *Rubus canadensis* Linné (dewberry) very closely resembles that of blackberry in medical properties.

Powder.—Light brown. Characteristic elements: Parenchyma of cortex, thin-walled, with starch, spherical (3 to 7 μ in diam.), thick, porous, elongated; bast fibers, walls of medium thickness, with some starch; wood fibers, ducts and tracheids, numerous with simple pores; cork considerable (20 to 30 μ in diam.); calcium oxalate crystals, aggregate (25 to 30 μ in diam.).

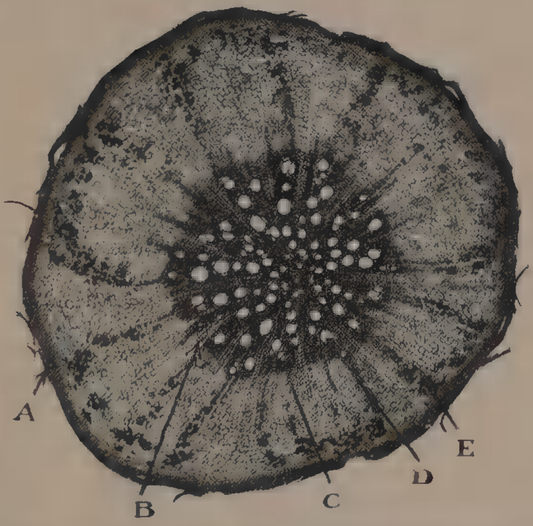

FIG. 94.—*Rubus villosus*—Cross-section of root, showing bark attached to wood. (17 diam.) A, Cork. B, Medullary ray. C, Xylem. D, Water tube. E, Groups of bast fibers. (Photomicrograph.)

CONSTITUENTS.—The virtues of the bark depend chiefly upon the tannin present, about 10 to 15 per cent.

ACTION AND USES.—Tonic and astringent. From a popular domestic remedy it has come into extensive use in the treatment of diarrhea, dysentery, and relaxed conditions of the bowels generally. Dose: 15 to 30 gr. (1 to 2 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Rubi,..................Dose: 30 to 60 ♏ (2 to 4 Cc.).
Syrupus Rubi (25 per cent. of fluidextract), 1 to 2 fl. dr. (4 to 8 Cc.).

181. **RUBUS IDÆUS.**—RASPBERRY. The fruit of **Ru'bus idæ'us** Linné. Off. U. S. P. 1890. A collective fruit, hemispherical, about 12 mm. ($\frac{1}{2}$ in.) broad; it consists of numerous small, red, hairy drupes united at the base around the receptacle, from which the coalesced fruits are easily removed, leaving a conical cavity. Contains a bright red, acidulous juice; odor agreeable. Used only in the fresh state. The purplish-black fruit of

Rubus occidentalis Linné may be substituted for it. *Constituents:* Sugar, citric and malic acids, pectin, proteids, a coloring-matter, and a trace of volatile oil. Refrigerant. Generally used as a flavoring agent or as a vehicle. Vehicle, **Syrupus Rubi Idæi**, U. S. P. 1890.

182. **CRATÆGUS.**—The fruit of **Cratæ'gus oxyacan'tha,** English Hawthorn. Heart tonic. Its value as a cardiac stimulant and tonic has recently come to the medical profession through Dr. M. C. Jennings, of Chicago. Dose of fluidextract: 10 to 15 ♍ (0.6 to 0.9 Cc.).

FIG. 95.—*Rubus idæus*—Branch.

183. **LAUROCERASUS.**—CHERRY LAUREL. The leaves of **Pru'nus lauro-cera'sus** Linné, an ornamental shrub native to Western Asia. They contain an amygdalin-like principle, **laurocerasin,** and a ferment. Odor bitter, almond-like; taste aromatic and bitter. Used in making cherry-laurel water, a preparation much employed in Europe as a sedative narcotic, much as the dilute hydrocyanic acid is used here.

184. **FRAGARIA VESCA** Linné.—STRAWBERRY. (Leaves.) Mild astringent and diuretic. Dose: 1 dr. (4 Gm.), in infusion.

185. CUSSO.—Kousso.

KOOSO. BRAYERA. *Ger.* KUSSO.

The dried panicles of the pistillate flowers of **Hage'nia abyssin'ica** Gmelin.

BOTANICAL CHARACTERISTICS.—A large ornamental tree with crowded-pinnate *leaves.* *Flowers* diœcious, in panicles, small, greenish, becoming purplish

or reddish. *Male flowers*—calyx bracteate, 10-sepaled; stamens 10 to 25. *Female flowers*—petals linear; carpels 2, with hairy styles. *Fruit* a nut. Only the female flowers are collected.

HABITAT.—Abyssinia.

DESCRIPTION OF DRUG.—Small, reddish, pistillate flowers, consisting of

FIG. 96.—*Hagenia abyssinica*—Flowering branch, and male and female flowers.

two reddish bracts and a calyx of five reddish, hairy sepals inclosing one or two nutlets. They come into market in cylindrical bundles of the compressed panicles, or detached, on short, hairy peduncles; odor tea-like; taste bitter and nauseous. In trade the "brown" and "red" kusso are known. The former are mixed with male flowers.

In the "red," the best variety, the sepals are reddish; in the "brown" they are greenish or brownish and smaller.

Powder.—Light brown. Characteristic elements: These are to be found in the glandular trichomes consisting of stalks, 2 to 3 celled, head 1, 2, 4 celled; non-glandular trichomes, one-celled, curved; few ellipsoidal pollen grains. Powder seldom dispensed.

CONSTITUENTS.—The chief constituents are **kosotoxin** (amorphous), a muscle poison, and **protokosin** (crystalline), inactive. Kosotoxin with baryta water yields a neutral body said to be identical with commercial **kosin,** an active principle soluble in alkalies; **tannin** 24 per cent., and a tasteless and an acrid **resin.**

Preparation of Kosin.—Heat cusso repeatedly with alcohol to which calcium hydrate has been added, boil residue with water, mix liquids, filter, and distil. Kosin is then precipitated by treating the solution with acetic acid. Is in flocculent form, soon becoming dense and resin-like. Purified by crystallization.

ACTION AND USES.—Tænifuge. Dose: 2 to 8 dr. (8 to 30 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Cusso (U. S. P. 1890), . . Dose: 1 to 4 fl. dr. (4 to 15 Cc.).

186. **TORMENTILLA.**—TORMENTIL. The rhizome of **Potentil'la tormentil'la** Sibthorp. *Habitat:* Europe. Large, somewhat fusiform, longitudinally wrinkled, and rough from numerous stem and rootlet scars; externally dull reddish-brown; fracture smooth, showing a pale reddish interior, consisting of one or two distinct circles of wood-fiber around a large central pith; inodorous; taste astringent. Used as a tonic and astringent. Dose: 10 to 30 gr. (0.6 to 2 Gm.), in powder or decoction.

187. **GEUM URBANUM.**—AVENS. EUROPEAN AVENS. The rhizome of **Ge'um urba'num** Linné. *Habitat:* Europe. Short, oblong, hard, with a dark brown, warty, and scaly surface; a cross-section shows a thin bark, and a large, reddish pith surrounded by a circle of whitish wood. The rootlets are long and fibrous, light brown in color, and have a comparatively thicker bark. Odor aromatic, slightly clove-like when fresh, but nearly absent when dry; taste aromatic, bitter, and astringent. Used as an astringent and tonic. Dose: 15 to 45 gr. (1 to 3 Gm.), in powder or decoction.

188. **GEUM RIVALE** Linné.—WATER AVENS. (Rhizome.—See Conspectus.) Astringent and tonic. Dose: 15 to 45 gr. (1 to 3 Gm.).

189. **GILLENIA.**—AMERICAN IPECAC. The rhizome of **Gille'nia stipula'cea** Nuttall. *Habitat:* Western United States. A knotty rhizome, with numerous tortuous, annulate rootlets, the thick bark of which is in two reddish layers and incloses a tough, whitish, finely-rayed wood. *Gillenia trifoliata* Moench, growing east of the Allegheny Mountains, is a smaller and less knotty rhizome, and the rootlets are nearly straight and smooth. Both rhizomes are similar in medical properties, being mildly emetic and cathartic, somewhat resembling ipecac in action. Dose: 15 to 30 gr. (1 to 2 Gm.).

190. **AGRIMONIA.**—AGRIMONY. The herb of **Agrimo'nia eupato'ria** Linné. Common in the United States west to the Rocky Mountains, and in Europe. Tonic and astringent. Dose: 30 to 60 gr. (2 to 4 Gm.).

191. **POTENTILLA CANADENSIS** Linné.—CINQUEFOIL. *Habitat:* North America. (Herb.) Astringent. Dose: 30 to 60 gr. (2 to 4 Gm.), in infusion.

192. **SPIRÆA TOMENTOSA** Linné.—HARDHACK. An indigenous herb used as an astringent and tonic in doses of 30 to 60 gr. (2 to 4 Gm.). As found in market it consists of the slender, reddish-brown stems, broken leaves covered below with a rust-brown wool, and a few of the dull reddish flower-petals. Odor slight, aromatic; taste astringent and bitter.

SAXIFRAGEÆ.—Saxifrage Family.

193. **HEUCHERA.**—ALUM ROOT. The root of **Heu'chera america'na** Linné. (See Conspectus.) *Habitat:* United States. It contains about 14 per cent. of tannin, and is a powerful astringent in doses of 15 to 30 gr. (1 to 2 Gm.).

194. **HYDRANGEA.**—The root of **Hydran'gea arbores'cens** Linné. (See Conspectus.) *Habitat:* United States. It consists of several bent, branched roots, arising from a thick, knotty head, or, as usually seen, of pieces of these roots cut up into various lengths. The rather thick, light gray, or pale brown bark is longitudinally ridged and covered with rust-colored patches, and separates easily from the tough, white, tasteless wood; wood-wedges long, narrow; odorless; taste of bark sweetish, afterward pungent. Used as a diuretic and as an antilithic in those cases where there is an alkalinity of the urine and a tendency toward the deposition of phosphatic calculi. Dose: 30 to 60 gr. (2 to 4 Gm.).

195. **MITELLA NUDA** Linné. COOLWORT. (Leaves.) Diuretic; used in inflammatory and catarrhal affections of the bladder and kidneys.

CRASSULACEÆ.—Orpine Family.

196. **SEDUM ACRE.**—BITING STONE-CROP. ENGLISH MASS. The whole plant, **Se'dum a'cre** Linné. *Habitat:* Europe; cultivated in New England gardens. It is said to be very successful in the treatment of diphtheritic sore throat, by dissolving and expelling the false membrane. Dose: 15 to 30 gr. (1 to 2 Gm.).

197. **PENTHORUM.**—VIRGINIA STONE-CROP. The herb of **Pentho'rum sedoi'des** Linné. Astringent, demulcent, and laxative, in diseases of the mucous membranes. Dose: 15 to 30 gr. (1 to 4 Gm.).

DROSERACEÆ.—Sundew Family.

198. **DROSERA.**—SUNDEW. The herb of **Drose'ra rotundifo'lia** Linné. (See Conspectus.) *Habitat:* North America and Europe. Used principally as a pectoral in bronchitis, coughs, etc. Dose: 5 to 15 gr. (0.3 to 1 Gm.).

HAMAMELIDACEÆ.—Witchhazel Family.

Shrubs or trees with alternate, simple *leaves* and deciduous stipules. *Flowers* in heads or spikes, often polygamous or monœcious. *Fruit* a woody capsule, 2-beaked, 2-celled, 2-seeded. A family which contains but few species, but is dispersed over both hemispheres. The wood of a tree, Parrolin, is extremely hard, and in Persia is called iron-wood.

Synopsis of Drugs from the Hamamelidaceæ.

A. *Leaves*
  HAMAMELIDIS FOLIA, 199.

B. *Bark.*
  HAMAMELIDIS CORTEX, 200.

C. *Balsam.*
  STYRAX, 201.
  Liquidambar, 202.

199. HAMAMELIDIS FOLIA.—Hamamelis Leaves.

WITCHHAZEL. *Ger.* ZAUBERHASEL.

The dried leaves of **Hamame'lis virgin'iana** Linné, collected in autumn and carefully preserved.

Botanical Characteristics.—Woody shrub 5 to 15 feet high. *Leaves* oval or obovate, crenate-dentate, obliquely cordate at base, on short petioles. *Flowers* appearing very late, even in the winter, sessile, 3 or 4 together in an involucrate, axillary, subsessile glomerule. "The small branches have been superstitiously used for 'divining rods' to indicate the presence of the precious metals and of deep springs of water."

Habitat.—North America.

Description of Drug.—Leaves broadly elliptical to obovate, more or less unequal, 3.5 to 12 cm. long, 2.5 to 7 cm. broad; apex rounded, acute or acuminate; base obliquely cordate; margin sinuate or sinuate-dentate. Upper surface dark green, midrib and veins prominent, veins of the first order running nearly parallel to the margin; under surface light green, texture coarse, brittle; odor slight; taste astringent. **The drug is sometimes broken and in more or less compact masses.**

Powder.—Dull green. Characteristic elements: The trichomes, one-celled, in groups of 8 to 15, radiating from a center; crystal fibers, calcium oxalate prisms, and stomata. Seldom employed as powder.

Constituents.—Gallic acid; hamamelo-tannic acid, $C_{14}H_{14}O_9 + 5H_2O$, resin, and extractive. **Distilled Extract of Witchhazel, Hamamelis Water, Aqua Hamamelidis,** is prepared from hamamelis bark by macerating the bark in water for twenty-four hours, then distilling the product until the distillate reaches 85 per cent. of the bark used; then add 15 per cent. of alcohol. It has a peculiar odor, a somewhat saccharine taste, is quite stable, and presents no pharmaceutical, chemical, or therapeutical incompatibility. Its mode of preparation has been to some extent a trade secret, but the above formula furnishes a good preparation. This preparation has built up quite an industry along the Connecticut Valley, where the distillation of the liquid is performed almost exclusively.

Action and Uses.—It has come into extensive use as an **astringent** in hemorrhoids and internal hemorrhages, and as a general **vulnerary.** The distillate, known as "Extract of Witchhazel," is alleged to have properties which are not professionally recognized. Average dose: 30 gr. (2 Gm.).

Official Preparation.

Fluidextractum Hamamelidis Foliorum,...Dose: 10 to 60 ♏ (0.6 to 4 Cc.).

200. **HAMAMELIDIS CORTEX.**—Witchhazel Bark. Thin pieces covered with an easily separable grayish or grayish-brown cork, more or

less covered with blackish dots and scars. When deprived of this layer, the bark is pale cinnamon-brown, fibrous. Odorless; taste astringent, bitter, and somewhat pungent. Its medical properties are the same as those of the leaves. The bark and twigs are official under the above title.

201. STYRAX.—Storax.

LIQUID STORAX. *Ger.* FLÜSSIGER STORAX.

A balsam obtained from the wood and inner bark of **Liquid'ambar orienta'lis** Miller.

Origin and Sources.—Much useful and interesting information regarding the history and sources of storax may be found in Flückiger's Pharmacographia and in the Pharmacographia Indica. According

Fig. 97.—*Liquidambar orientalis*—Branch.

to Royle, the source of the true storax—a variety of benzoin formerly obtained in fine tears—is *Storax officinale* Linné, a small tree with smooth bark; the little of this article now obtained is used by the churches and mosques of the countries which produce it. The official liquid storax, however, is obtained from a different source: The

Action and Uses.—Used as a febrifuge, stimulant, and astringent. Its principal action, however, is that of the volatile oil, or rather its

Fig. 98.—*Eucalyptus globulus*—Branch.

chief constituent, eucalyptol, $C_{10}H_{18}O$, **antiseptic.** Dose: ½ to 2 dr. (2 to 8 Gm.). Dose of eucalyptol: 5 ♏ (0.3 Cc.).

Official Preparation.

Fluidextractum Eucalypti, ...Dose: 5 to 60 ♏ (0.3 to 4 Cc.).

OLEUM EUCALYPTI, U. S.—A colorless or yellowish volatile oil, distilled from the fresh leaves. It has a spicy, cooling taste, and somewhat camphoraceous odor. Consists of two hydrocarbons (cymene, $C_{10}H_{14}$, and eucalyptene, $C_{10}H_{16}$), a terpene, and **eucalyptol,** $C_{10}H_{18}O$, upon which its value depends. Eucalyptol is now official in the U. S. Pharmacopœia; it is obtained as one of the fractions in the distillation of the oil, coming over between 170° to

FIG. 99.—*Myrcia acris*—Branch with fruit.

178° C. It is a nearly colorless liquid, with a strong, aromatic, camphoraceous odor; slightly soluble in water, but very soluble in alcohol, carbon disulphide, and glacial acetic acid. Dose: 5 to 10 ♏ (0.3 to 0.6 Cc.). Antiseptic. Dose of the oil: 5 to 15 ♏ (0.3 to 1 Cc.).

204 a. **RED GUM.**—The resin or inspissated juice of **Eucalyptus rostrata** Schlecht. *Synonyms:* CREEK GUM, MURRAY RED GUM, RED GUM KINO, EUCALYPTI GUMMI. *Habitat:* Australia. Small, angular, ruby-red, shining pieces; in thin layers transparent. Resembles kino, but has a brighter appearance and is less astringent. The taste is bitter. Almost entirely dissolved by alcohol. *Properties:* A good astringent, similar to kino. *Preparations:* Fluid and lozenges. *Uses:* Checks the purging of mercurial pills administered for syphilis. Has been recommended for seasickness. Dose: 5 to 20 minims of the fluid.

205. **MYRCIA.**—Bay Leaves. Wax Myrtle. Wild Clove Leaves. The leaves of **Myr'cia ac'ris** De Candolle, a West Indian tree. These leaves are aromatic and spicy, containing a volatile oil, which, when distilled, forms the Oleum Myrciæ, U. S., and when distilled over with rum, forms bay rum (Spiritus Myrciæ, U. S.).

205 a. **OLEUM MYRCIÆ** (1890).—Oil of Bay. A volatile oil distilled from bay leaves. It is a brownish-yellow, slightly acid liquid, having an agreeable, somewhat clove-like odor, and a warm, spicy taste; sp. gr. 0.96 to 0.98. See Tests in U. S. Pharmacopœia. It consists of a light and a heavy oil,—the light a hydrocarbon identical with that of cloves and allspice, the heavy composed chiefly of **eugenol.**

Action and Uses.—Admitted into the U. S. P. of 1890 as an ingredient in Spiritus Myrciæ.

Official Preparation.

Spiritus Myrciæ (U. S. P. 1890) (8 per cent., with the oils of orange-peel and pimenta). Artificial Bay Rum.

206. **CHEKAN.**—Cheken. The leaves of a Chilian evergreen shrub, **Euge'nia che'kan** Molina. Tonic, expectorant, with some diuretic action. Dose of the fluidextract: 30 to 60 ♏ (2 to 4 Cc.).

207. CARYOPHYLLUS.—Cloves.

CLOVES. *Ger.* GEWÜRZNELKEN.

The dried flower buds of **Euge'nia aroma'tica** O. Kuntze.

Botanical Characteristics.—A shrubby evergreen, with hard wood, covered with a smooth, gray bark. *Leaves* opposite, ovate-lanceolate, coriaceous. *Petals* 4, globular in bud, afterward spreading, whitish, aromatic. *Ovary* 2-celled; *fruit* a large, elliptical berry.

Source.—The original habitat of the clove tree was the Molucca Islands, but they have been introduced into other East Indian Islands, into Zanzibar (which now forms the principal source), and into Cayenne. They are picked singly while green and are dried in the sun. Commercial: There are several varieties, as Molucco, Sumatra, and South American, the latter being rather inferior.

Description of Drug.—Cloves are about 15 mm. ($\frac{3}{5}$ in.) long, of a dark brown or reddish-brown appearance; the calyx tube is long, nearly cylindrical, crowned with the four stiff teeth (clasping the unexpanded corolla); **corolla** of four lighter colored, **unexpanded petals, forming a hollow ball on the top of the calyx-tube,** inclosing the numerous curved stamens and the single style; the ovary is inferior, situated near the top of the calyx-tube, and consists of two cells, each containing many ovules. **A cross-section** of the lower

part of the calyx-tube under the microscope shows a thin outer layer surrounding a darker zone; this outer layer contains a double ring of oil cells; the inner darker zone contains an outside circle of about thirty fibrovascular bundles, with a larger bundle running through the center. **Odor** highly aromatic, especially when scratched; **taste** pungent and aromatic, followed by slight numbness.

FIG. 100.—*Eugenia aromatica.*

Powder.—Deep brown. Characteristic elements: Outer parenchyma cells closely united, with aggregate calcium oxalate crystals (10 to 15 μ in diam.); inner parenchyma spongy; sclerenchyma with bast fibers, short, thick-walled, strongly lignified, simple and oblique pores; ducts, spiral, thick-walled; pollen triangular, tetrahedral, spheroidal, 3-pored, about 15 μ in diam. Frequently adulterated with clove stalks, the ripe fruit, etc., to detect which requires special study.

CONSTITUENTS.—**About 18 per cent. of volatile oil,** 17 per cent. of tannin, a little fixed oil, gum, resin, etc. Two crystalline principles

have been separated, caryophyllin, $C_{10}H_{16}O$, white, odorless, and tasteless, resinous, and eugenin, $C_{10}H_{12}O_2$, isomeric with eugenol of the volatile oil, soluble in boiling alcohol and ether, as is also caryophyllin, but differing from the latter in turning red with nitric acid, vanillin. Water extracts the volatile oil with scarcely any of the pungency of taste.

Preparation of Caryophyllin.—Treat ethereal extract of cloves with water, collect precipitate, and purify with ammonia.

Action and Uses.—Stimulant and carminative, used mostly as a **synergist.** Dose: 5 to 10 gr. (0.3 to 0.6 Gm.).

Official Preparation.

Tinctura Lavandulæ Composita (0.5 per cent.), ...Dose: ½ to 2 fl. dr. (2 to 8 Cc.).
Vinum opii. Tinctura Rhei Aromatica.

207 **a. MOTHER CLOVES.**—The ripe fruit, or Mother Cloves, resembles cloves in appearance, but is thicker and somewhat lighter in color and less aromatic; the **corolla is absent,** but the calyx-teeth still adhere.

207 **b. OLEUM CARYOPHYLLI,** U. S.—Oil of Cloves. A pale yellowish-brown, thin liquid, becoming reddish-brown on exposure. It has a specific gravity of 1.065, and boils at about 250° C.; slightly acid; taste aromatic and hot; odor characteristic, aromatic. (See Tests in U. S. P.) Oil of cloves consists of two oils—one lighter than water, the other heavier; the light oil, caryophyllene, $C_{15}H_{24}$, sp. gr. 0.91, is a pure hydrocarbon, and is thought to be inactive; the heavy oil is a phenol-like liquid termed **eugenol,** or eugenic acid, $C_{10}H_{12}O_2$, sp. gr. 1.076.

Action and Uses.—Used for the same purposes as cloves, more commonly, however, for introduction into an **aching, carious tooth.** Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.).

208. PIMENTA.—Pimenta.

ALLSPICE. *Ger.* NEUGEWÜRZ.

The nearly ripe dried fruit of **Pimen'ta officina'lis** Lindley.

Botanical Characteristics.—An elegant tree about 30 feet high, evergreen. *Leaves* pellucid-punctate, petiolate. *Flowers* in racemes, white. *Calyx* and *petals* 4-fold, the latter greenish-white. *Fruit* a berry, covered by the roundish, persistent base of the calyx. After ripening, they lose their aromatic warmth and acquire a somewhat juniper-like taste; hence they are gathered in the unripe state.

Source.—West Indies, Mexico, and South America, the principal source

being Jamaica—from which it has received the name of Jamaica pepper.

DESCRIPTION OF DRUG.—Globular, about the size of a large pea; picked while yet green, becoming wrinkled and brownish on drying, with the four calyx-teeth and the short style still adherent to the apex, or

FIG. 101.—*Pimenta officinalis*—Branch and flower.

a raised ring marking the position of the calyx-teeth; it is divided into two cells, each of which contains a single, brownish, plano-convex seed. The pericarp is finely tuberculated with numerous oil tubercles. **Odor** spicy and agreeably pungent; **taste** clove-like.

Powder.—Reddish-brown. Characteristic elements: Parenchyma of endosperm, with starch and resin; parenchyma of pericarp, with starch, resin, and

have been separated, caryophyllin, $C_{10}H_{16}O$, white, odorless, and tasteless, resinous, and eugenin, $C_{10}H_{12}O_2$, isomeric with eugenol of the volatile oil, soluble in boiling alcohol and ether, as is also caryophyllin, but differing from the latter in turning red with nitric acid, vanillin. Water extracts the volatile oil with scarcely any of the pungency of taste.

Preparation of Caryophyllin.—Treat ethereal extract of cloves with water, collect precipitate, and purify with ammonia.

ACTION AND USES.—Stimulant and carminative, used mostly as a **synergist.** Dose: 5 to 10 gr. (0.3 to 0.6 Gm.).

OFFICIAL PREPARATION.

Tinctura Lavandulæ Composita (0.5 per cent.), ... Dose: ½ to 2 fl. dr. (2 to 8 Cc.).
Vinum opii. Tinctura Rhei Aromatica.

207 a. **MOTHER CLOVES.**—The ripe fruit, or Mother Cloves, resembles cloves in appearance, but is thicker and somewhat lighter in color and less aromatic; the **corolla is absent,** but the calyx-teeth still adhere.

207 b. **OLEUM CARYOPHYLLI,** U. S.—OIL OF CLOVES. A pale yellowish-brown, thin liquid, becoming reddish-brown on exposure. It has a specific gravity of 1.065, and boils at about 250° C.; slightly acid; taste aromatic and hot; odor characteristic, aromatic. (See Tests in U. S. P.) Oil of cloves consists of two oils—one lighter than water, the other heavier; the light oil, caryophyllene, $C_{15}H_{24}$, sp. gr. 0.91, is a pure hydrocarbon, and is thought to be inactive; the heavy oil is a phenol-like liquid termed **eugenol,** or eugenic acid, $C_{10}H_{12}O_2$, sp. gr. 1.076.

ACTION AND USES.—Used for the same purposes as cloves, more commonly, however, for introduction into an **aching, carious tooth.** Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.).

208. PIMENTA.—PIMENTA.

ALLSPICE. *Ger.* NEUGEWÜRZ.

The nearly ripe dried fruit of **Pimen'ta officina'lis** Lindley.

BOTANICAL CHARACTERISTICS.—An elegant tree about 30 feet high, evergreen. *Leaves* pellucid-punctate, petiolate. *Flowers* in racemes, white. *Calyx* and *petals* 4-fold, the latter greenish-white. *Fruit* a berry, covered by the roundish, persistent base of the calyx. After ripening, they lose their aromatic warmth and acquire a somewhat juniper-like taste; hence they are gathered in the unripe state.

SOURCE.—West Indies, Mexico, and South America, the principal source

being Jamaica—from which it has received the name of Jamaica pepper.

Description of Drug.—Globular, about the size of a large pea; picked while yet green, becoming wrinkled and brownish on drying, with the four calyx-teeth and the short style still adherent to the apex, or

Fig. 101.—*Pimenta officinalis*—Branch and flower.

a raised ring marking the position of the calyx-teeth; it is divided into two cells, each of which contains a single, brownish, plano-convex seed. The pericarp is finely tuberculated with numerous oil tubercles. **Odor** spicy and agreeably pungent; **taste** clove-like.

Powder.—Reddish-brown. Characteristic elements: Parenchyma of endosperm, with starch and resin; parenchyma of pericarp, with starch, resin, and

calcium oxalate in aggregate crystals about 10 μ in diam.; sclerenchyma with stone cells, having simple, branching pores; trichomes, short, one-celled; large oil and resin ducts; starch grains, spherical, 10 μ simple or compound.

CONSTITUENTS.—The properties depend upon a **volatile oil** and a green, acrid **fixed oil,** existing to the extent of 10 per cent. and 8 per cent. respectively in the pericarp, and in considerably less quantities in the embryo.

ACTION AND USES.—Stimulant and carminative, as an **adjuvant** to tonic and purgative mixtures. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

208 a. **OLEUM PIMENTÆ,** U. S.—A colorless, or pale yellow, volatile oil, becoming thick and reddish-brown by age. Specific gravity 1.04 to 1.05. It closely resembles oil of cloves (*q. v.*), but has a more pleasant and less pungent odor; taste aromatic. Consists, like oil of cloves, of a light and a heavy oil, the heavy oil being identical with eugenol.

ACTION AND USES.—Same as the other stimulant aromatic oils. Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.).

OFFICIAL PREPARATION.

Spiritus Myrciæ (U. S. P., 1890) (0.05 per cent.).

209. **JAMBUL.**—JAVA PLUM. A large tree, **Eugen'ia jambola'na,** growing in the East Indies, where its fruit is eaten as a food. All parts are astringent, but the bark, and especially the seeds, possess, in addition, the peculiar property of arresting the formation of sugar in diabetes, and hence are "likely to prove a valuable remedy in this disease." Dose: 5 to 10 gr. (0.3 to 0.6 Gm.).

210. OLEUM CAJUPUTI.—OIL OF CAJUPUT.

OIL OF CAJUPUT. *Ger.* CAJUPUTOEL.

A volatile oil distilled from the leaves of **Melaleu'ca leucaden'dron** Linné

BOTANICAL CHARACTERISTICS.—A tree with crooked stem and scattered branches, the branchlets drooping like those of the weeping willow; bark whitish. *Leaves* lanceolate, deep green, entire, from 3 to 4 inches long. *Flowers* small, white, inodorous, in axillary spikes.

HABITAT.—East Indies.

DESCRIPTION OF DRUG.—A light bluish-green (probably due to copper), limpid liquid having a penetrating, agreeable odor, and a warm, camphoraceous, bitter, afterward saline or cooling, taste. Specific gravity 0.925. It has a slightly acid reaction.

CONSTITUENTS.—The principal constituent is the hydrate of the hydrocarbon, cajuputene, $C_{10}H_{16}$ (**Cajuputol,** $C_{10}H_{16}H_2O$), said to be identical with eucalyptol, or cineol, from eucalyptus. The commer-

cial oil often contains a trace of copper, not in large enough quantities to be dangerous, however.

ACTION AND USES.—Highly stimulant, carminative, and a counter-irritant in rheumatism. Dose: 1 to 10 ♏ (0.065 to 0.65 Cc.).

FIG. 102.—*Melaleuca leucadendron*—Branch.

PUNICACEÆ.—Pomegranate Family.

211. GRANATUM.—POMEGRANATE.

POMEGRANATE. *Ger.* GRANATWURZELRINDE.

The stem-bark and root-bark of **Pu'nica grana'tum** Linné.

BOTANICAL CHARACTERISTICS.—Tree shrubby, 20 feet in height; branches numerous, sometimes bearing thorns. *Leaves* opposite, entire, oblong, pointed at each end. *Flowers* large, rich scarlet, terminal. *Fruit* a berry

about the size of an orange; rind thick, having a reddish-yellow exterior; pulp many-seeded, acidulous.

HABITAT.—Mediterranean Basin and various portions of Asia; cultivated in all warm climates for its ornamental flowers.

DESCRIPTION OF DRUG.—The stem bark comes occasionally in quills, more frequently in curved pieces 20 to 80 mm. long, 5 to 20 mm. in diameter; bark 0.5 to 2 mm. thick, outer surface yellowish-brown, with grayish patches; longitudinally wrinkled; small lenticels. Inner surface light yellow or brownish-yellow, finely striate, smooth. Fracture short, smooth, inner layer of bark (phelloderm) dark green, inner bark light brown, odor slight; taste astringent, somewhat bitter.

FIG. 103.—*Punica granatum*—Branch with flowers.

The root bark has a rough, yellowish-gray to brown outer surface, marked with more or less longitudinal patches of cork, green inner layer of bark absent. Medullary rays extending nearly to the outer layer; inner surface smooth and yellowish with irregular brownish blotches.

A process of assay has been suggested, consisting of an extraction and separation of the alkaloid from the drug by immiscible solvents (chloroform and acidulated water) and titrating a final solution of the alkaloid against $\frac{N}{10}$ hydrochloric acid. ("Drug. Circ.," June, 1901, p. 212.)

STRUCTURE.—The tissue consists chiefly of large-celled parenchyma,

traversed by one-rowed medullary rays of quadratic cells, each ray accompanied by a single row of crystal cells. The inner bark steeped in water and then **rubbed on paper produces a yellow stain,** which is **rendered blue by ferrous sulphate, and rose-red by nitric acid,** soon vanishing. These properties distinguish it from the bark of the box-root and the barberry, with which it is sometimes adulterated.

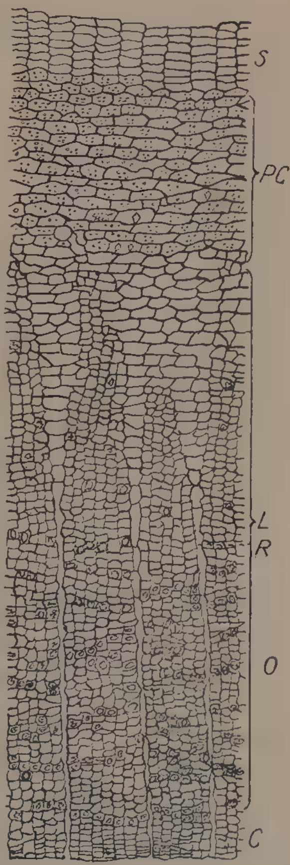

FIG. 104.—*Punica granatum*—Cross-section of bark of the stem. *S*. Suberous layer. *PC*. Cortical parenchyma. *L*. Liber. *R*. Dotted line extends to narrow medullary ray. *O*. Stands opposite a tangential row of oxalate of calcium crystals, which are numerous throughout the phloem. *C*. Cambium.

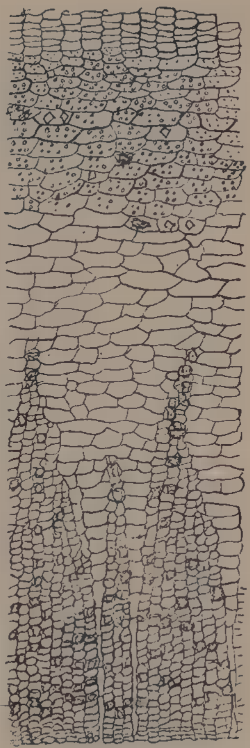

FIG. 105.—*Punica granatum*—Cross-section of the bark of the root.

Powder.—Pale yellowish-brown. Characteristic elements: Parenchyma of cortex, inner cells small with starch, spherical (5 to 20 μ in diam.), middle cells thick-walled, calcium oxalate aggregate and prisms about 15 μ in diam.; sclerenchyma consisting of few stone cells, large, thick-walled.

CONSTITUENTS.—Mannite, punico-tannic acid, 22 per cent. (resolved by hydrolysis into sugar and ellagic acid), and the active constituent, **pelletierine,** $C_8H_{13}NO$, with its three allied alkaloids, **methyl-**

pelletierine, $C_9H_{17}NO$, **pseudo-pelletierine,** $C_9H_{15}NO$, and **iso-pelletierine.** Pelletierine is a liquid alkaloid, readily soluble in water, alcohol, and ether. Several salts of it are made, but the **tannate** is the **official** one. This is yellowish, hygroscopic, and pulverescent, with a pungent astringent taste, soluble in 700 parts of water and 80 parts of alcohol.

Preparation of Pelletierine.—Displace powder with water mixed with lime, exhaust percolate with chloroform, etc. It is claimed by Tanret to be the anthelmintic constituent. Is probably a mixture of several alkaloids.

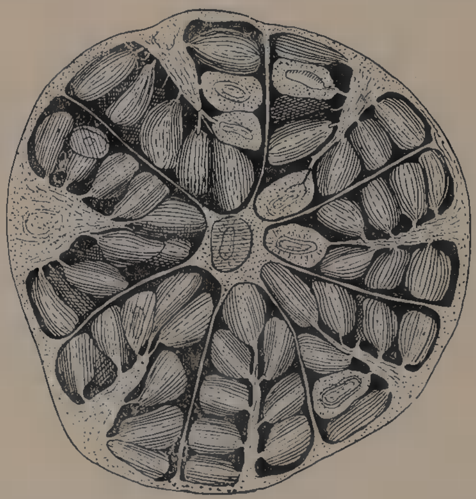

FIG. 106.—*Pomegranate*—Cross-section of fruit.

ACTION AND USES.—Astringent, **tæniafuge.** Dose: ½ to 1½ dr. (2 to 6 Gm.). The alkaloid pelletierine is a tæniafuge in extensive use; it is given in the form of tannate in doses of about 5 gr. (0.3 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Granati, ...Dose: 1 to 2 fl. dr. (4 to 8 Cc.).

212. **GRANATI FRUCTUS CORTEX.**—POMEGRANATE RIND. Irregular fragments, of a yellowish or reddish-brown color; outer surface rough from tubercles; inner surface marked with small depressions; hard; brittle. It contains a greater proportion of tannin than the bark, but has the same medical properties.

ONAGRARIEÆ.—Evening Primrose Family.

213. **EPILOBIUM.**—WILLOW-HERB. The herb of **Epilo'bium angustifo'lium** Linné. *Habitat:* Northern Hemisphere. It has a smooth, reddish stem, branching above, arising from a long, yellowish-white root, and bearing the purplish-pink flowers in a raceme resembling those of the willow; hence the name willow-herb. Demulcent and astringent. Dose: 30 to 60 gr. (2 to 4 Gm.).

214. **ŒNOTHERA BIENNIS** Linné.—EVENING PRIMROSE. *Habitat:* North America. (Herb. See Conspectus.) Astringent, alterative.

TURNERACEÆ.

215. **TURNERA.**—Damiana. The leaves of a Mexican plant, **Turnera aphrodisiaca (T. diffu'sa** Willdenow). About 8 to 16 mm. (⅓ to ⅔ in.) long, obovate or lanceolate, with a few-toothed margin; surface smooth or with a few hairs on the under side along the ribs. They generally have mixed with them pieces of the slender, woody stem, which is reddish-brown and hairy, the branches being terminated by hairs; odor somewhat aromatic, due to the presence of about 0.5 per cent. of volatile oil. Damiana leaves form the basis of a large number of the quack aphrodisiacs now in the market. T. U. Lloyd recently investigated the plant in its home, and finds it was introduced to American medicine under a misunderstanding of its nature. It is not known as a *drug* in Mexico, but as a general tea-like beverage. Dose: about 1 dr. (4 Gm.), in infusion.

PASSIFLOREÆ.—Passion-flower Family.

216. **CARICA PAPAYA.**—Melon-tree. True Papaw (wholly different from the common papaw, **Asim'ina trilo'ba,** of our Southern States). *Habitat:* Tropics; cultivated. Although the inspissated juice (papain) of the unripe fruit has been for a long time known as a medicinal agent, having a reputation in its native country as a remedy for hæmoptysis, bleeding piles, and ulcers of urinary passages, and for ringworm, etc., it has only comparatively recently attracted attention as a digestive agent. Dymock, in his treatise on the drugs of British India, says: "Its digestive action on meat was probably known in the West Indies at a very early date. * * * It has long been the practice to render meat tender by rubbing it with the juice of the unripe fruit or by rubbing it with the leaves. Its therapeutic value, in the form of papain, is specially commended in aggravated symptoms of dyspepsia." Its constituents are mainly globulin, albumen, and albumoses. Dose: 1 to 3 gr. (0.065 to 0.2 Gm.).

217. **PASSIFLORA.**—Passion Flower. The herb of **Passiflo'ra incarna'ta** Linné; indigenous. Said by eclectic and homœopathic practitioners to be a narcotic, useful in neuralgia, sleeplessness, dysmenorrhœa, etc. Dose of a saturated tincture: 15 to 30 ♍ (1 to 2 Cc.).

CUCURBITACEÆ.—Gourd Family.

Succulent herbs, creeping or climbing by tendrils. *Leaves* alternate. *Flowers* monœcious and polygamous; *stamens* with long and wavy or twisted anthers. *Fruit* a pepo.

Synopsis of Drugs from the Cucurbitaceæ.

A. *Root.*
  Bryonia, 218.

B. *Fruits.*
  COLOCYNTHIS, 219.
  Luffa, 220.
  Momordica, 221.

C. *Seeds.*
  PEPO, 222.
  Citrullus, 223.
  Cucumis, 224.

D. *Resin.*
  Elaterium, 225.

218. COLOCYNTHIS.—Colocynth.

BITTER APPLE. *Ger.* KOLOQUINTEN.

The dried fruit of **Citrul'lus colocyn'this** Schrader, deprived of its rind.

Botanical Characteristics.—Stem procumbent, angular, hispid; *leaves* cordate-ovate, lobate; tendrils short. *Flowers* axillary, *female flowers*

solitary, *petals* yellow with greenish veins. *Fruit* globose, smooth, 6-celled, with very bitter pulp; seeds whitish, sometimes brownish.

HABITAT.—Asia, Europe, and Africa.

DESCRIPTION OF DRUG.—The fresh fruit has a marbled green surface, not very unlike the watermelon. It has a thick rind inclosing a white, spongy pulp, imbedded in which are numerous light-colored seeds. The fruit on drying loses about 90 per cent. of water, leaving a **very light, spongy, white or yellowish-white pulp, which, deprived of the seed,** constitutes the official drug. Colocynth "apples," as they appear in the market, contain the seeds, but are deprived of the rind; 50 to 100 mm. (2 to 4 in.) in diameter. A cross-

FIG. 107.—Colocynth—Portion of vine and whole fruit.

section of the spherical pulp ("apples") makes apparent three distinct wedges, each of which has two branches; this structure is due to the parietal placentæ, which project to the center of the fruit, then divide and turn back, making convoluting branches directed one toward the other. Inodorous; so **intensely bitter** that the bitterness is imparted to any object brought in contact with it.

Powder.—Pale yellowish-brown, some of the prominent characteristics are: The very large parenchyma cell having thin walls and simple pores, these are much broken; sclerenchyma with stone cells also present. If the powder is carelessly mixed with powdered seeds, numerous oil globules are present. The fine powder is seldom dispensed.

CONSTITUENTS.—Resin, gum, and amyloid principles. **Colocynthin,** $C_{56}H_{84}O_{23}$, a yellowish, somewhat translucent, bitter, and friable glucoside, is, perhaps, the most important constituent; it is contained in the pulp to the extent of about 2 per cent. Colocynthitin is a tasteless crystalline principle left after treating the alcoholic extract with cold water in preparing colocynthin.

Preparation of Colocynthin.—Exhaust alcoholic extract with water, precipitate with lead acetate and subacetate, remove lead from liquid by treating with H_2S, filter, then precipitate with tannin; suspend the tannate in alcohol, decompose with lead hydroxide, remove excess of lead by H_2S, filter, evaporate, and wash the residue with ether.

FIG. 108.—Transverse section of colocynth fruit.

FIG. 109.—Longitudinal section of colocynth fruit.

ACTION AND USES.—**A powerful hydragogue cathartic,** given in combination with weaker purgatives. Dose: 3 to 10 gr. (0.2 to 0.6 Gm.).

OFFICIAL PREPARATIONS.

Extractum Colocynthidis, ...	Dose: ½ to 2 gr. (0.0324 to 0.13 Gm.).
Extractum Colocynthidis Compositum (Extract Colocynth 16 per cent., with aloes, scammony, cardamom and soap), ...	5 to 25 gr (0.3 to 1.6 Gm.).
Pilulæ Catharticæ Compositæ (8 per cent. of compound extract), ...	2 to 5 pills.
Pilulæ Catharticæ Vegetabiles (6 per cent. of compound extract), ...	2 or 3 pills.

219. **BRYONIA.**—BRYONY. The root of **Bryo'nia al'ba** and of **Bryo'nia dioi'ca** Linné. Off. in U. S. P. 1890. A dull reddish-brown, longitudinally wrinkled root, usually appearing in the market in transverse disks about 50 to 100 mm. (2 to 4 in.) in diameter, of a white or yellowish-white color; bark thin, with a thin, friable cork; the bark is separated by a brown cambium line from the meditullium, in which the wood-bundles are arranged radically and concentrically; the wood-wedges and zones are separated by rather broad rays and concentric circles of parenchymatous tissue; fracture short. Inodorous; taste disagreeably bitter. The active principle is **bryonin,** $C_{48}H_{80}O_{19}$, an intensely bitter glucoside, soluble in water, but best extracted with strong alcohol. Obtained by precipitating

the hydro-alcoholic percolate with tannin. The moist tannin compound is mixed with lead oxide and then digested with alcohol. The alcoholic solution yields bryonin on evaporation. Drastic hydragogue cathartic, formerly much used in the treatment of dropsy, but now superseded by jalap. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

Tinctura Bryoniæ (10 per cent.)
(U. S. P., 1890), ...Dose: 1 to 4 fl. dr. (4 to 15 Cc.).

220. **LUFFA.**—VEGETABLE SPONGE. WASH-RAG SPONGE. GOURD TOWEL. The gourd-like fruit of **Luf'fa ægyp'tiaca,** a vine growing in Arabia and Egypt. The layer of tissue next the epidermis is composed of interwoven woody fibers, and, when deprived of the epidermis, makes a good substitute for sponge. The fruit of *Luffa echinata*, growing in India, contains a principle related to, if not identical with, colocynthitin.

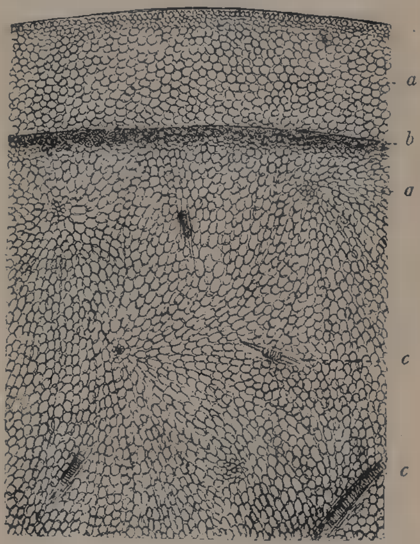

FIG. 110.—*Citrullus colocynthis*—Cross-section through outer portion of the fruit. *a*, *a*. Parenchyma. *b*. Stone cells. *c*, *c*. Fibro-vascular bundles.

221. **MOMORDICA BALSAMINA** Linné.—BALSAM APPLE. This is a climbing East Indian plant, cultivated in our gardens for the sake of its cucumber-like fruit, which is often used in domestic practice as a vulnerary.

222. PEPO.—PUMPKIN SEED.

PUMPKIN SEED. *Ger.* KÜRBISSAMEN.

The ripe seed of **Cucur'bita pe'po** Linné.

BOTANICAL CHARACTERISTICS.—Stem hispid, procumbent; tendrils branched. *Leaves* very large, cordate, palmately 5-lobed. *Fruit* yellow, very large (sometimes two feet in diameter), roundish or oblong, smooth, and furrowed.

HABITAT.—Tropical Asia and America.

DESCRIPTION OF DRUG.—Flat, broadly ovate seeds, about 20 mm. ($\frac{4}{5}$ in.) long, and 2 mm. ($\frac{1}{12}$ in.) thick, with a **flat ridge and shallow groove**

around the edge; testa **dull white,** inclosing two flat, white, oily cotyledons and a short radicle; inodorous; taste bland and oily.

CONSTITUENTS.—From 30 to 40 per cent. of a thick, red fixed oil, **an acrid resin,** considered to be the tæniafuge principle, starch, sugar, fatty acids, and the proteids, myosin and vitellin, the myosin precipitating from an infusion saturated with NaCl, and the addition of CO_2 separating out the vitellin, apparently identical with that of egg yolk.

ACTION AND USES.—Tæniafuge. Dose: 1 to 2 oz. (30 to 60 Gm.), in emulsion.

FIG. 111.—*Ecballium elaterium*—Branch with flowers.

223. **CITRULLUS.**—WATERMELON SEED. The seed of **Cucu'mis citrul'lus** Seringe. Indigenous to Southern Asia, but cultivated extensively in the United States. Differs from the pumpkin seed in being blackish-marbled or brownish in color, somewhat smaller, and with a blunt, ungrooved edge. They are used like pumpkin seeds as a tæniafuge, and also have diuretic and demulcent properties. Dose: 2 dr. to 2 oz. (8 to 60 Gm.).

224. **CUCUMIS SATIVUS** Linné.—CUCUMBER SEED. Flat and thin, lance-oblong, from 8 to 12 mm. ($\frac{1}{3}$ to $\frac{1}{2}$ in.) long, acutely edged, ungrooved, dull white in color. Resembles above in properties.

225. **ELATERIUM.**—A peculiar resinous substance obtained from the fruit of **Ecbal'lium elate'rium** A. Richards (squirting cucumber), a vine growing in the Mediterranean regions of Europe, Africa, and Asia. The fruit, when ripe, separates suddenly from its stalk, and the internal pressure forces the juice out of the aperture thus made in a stream; in collecting, therefore, the fruits are gathered green, sliced, and the juice expressed by slight pressure; on standing it deposits a sediment, which, when dried, forms the commercial Elaterium.

Elaterium is in flat pieces of varying sizes, **light and friable,** pale green when fresh, but taking on a **gray or light buff** color as it becomes older; the

surface is covered with small crystals of elaterin; odor somewhat tea-like; taste acrid and intensely bitter, due to the active ingredient, **elaterin,** which constitutes from 25 to 30 per cent. of the drug. This principle is insoluble in water, readily soluble in chloroform and hot alcohol; it is a violent irritant poison; its alcoholic solution is colored red by warm sulphuric acid; its carbolic acid solution, crimson, rapidly changing to scarlet. There is also present ecballin (soft, yellow, acrid), hydroelaterin, and elaterid.

ELATERINUM. *Elaterin.*—Exhaust elaterium with chloroform; add ether; white crystals deposit immediately. Wash with ether and recrystallize from chloroform. This principle is odorless and crystalline, is bitter and acrid in taste.

ACTION AND USES.—Elaterin is a **powerful hydragogue cathartic,** used in the treatment of dropsy. Dose: $\frac{1}{20}$ to $\frac{1}{12}$ gr. (0.003 to 0.005 Gm.). *Official Preparation:* **Trituratio Elaterini** (10 per cent.). Dose: $\frac{1}{2}$ gr. (0.030 Gm.).

CACTEÆ.—Cactus Family.

226. **CACTUS GRANDIFLORUS** Linné.—NIGHT-BLOOMING CEREUS. *Habitat:* Tropical America; cultivated as an ornamental herb. The fleshy, hexagonal flowering branches are used in the fresh state. Sedative and diuretic; useful in diseases of the heart when there is an irregularity of action. The tincture and fluidextract have of recent years been growing in popularity, but the supply of the drug seems difficult to obtain, and for this reason, partly, the drug is not official. Dose: 5 gr. (0.3 Gm.).

227. **ANHALONIUM LEWINI** Henning.—A Mexican cactus, acting powerfully as a cardiac and respiratory stimulant; it has been used to a slight extent in medicine in angina pectoris and asthmatic dyspnea.

UMBELLIFERÆ.—Parsley Family.

Herbs with hollow stems. The umbellate inflorescence—the general character of the order—gives rise to its name. The *fruit,* called a cremocarp (from *cremao,* to support, and *karpos,* fruit), is perhaps the most marked characteristic of the order; it originates from one ovary surmounted by 2 styles and often crowned by the limb of the calyx, and has 2 cells and 2 seeds. The entire fruit is usually ellipsoidal, but in the case of the coriander it is spherical; it divides itself into two *mericarps* (half-fruits) suspended by their summits from a slender axis (carpophore), usually 2-forked; each mericarp has 5 to 10 more or less prominent ridges (juga), in the furrows or grooves between which are several oil-tubes (vittæ), usually visible in cross-section; in anise there are usually 15, in coriander 2. The *roots* contain an abundance of aromatic resin.

Synopsis of Drugs from the Umbelliferæ.

A. *Fruits.*
- **ANISUM,** 228.
- **FŒNICULUM,** 229.
- **CONIUM,** 230.
- **CARUM,** 232.
- **CORIANDRUM,** 232.
- Anethum, 234.
- Apium, 235.
- Ajowan, 236.
- Petroselinum, 238 a.
- Phellandrium, 239.
- Cuminum, 240.
- Carota, 241.

B. *Leaves.*
- Conii Folia, 231.

C. *Volatile Oils.*
- **OLEUM ANISI,** 228 a.
- **OLEUM FŒNICULI,** 229 a.
- **OLEUM CARI,** 232 a.
- **OLEUM CORIANDRI,** 233 a.
- Oleum Anethi, 234 a.

D. *Gum Resins.*
- **ASAFŒTIDA,** 244.
- Galbanum, 245.
- Ammoniacum, 246

228. ANISUM.—Anise.

ANISE. *Ger.* ANIS.

The ripe fruit of **Pimpinel'la an'isum** Linné, obtained from cultivated plants.

Botanical Characteristics.—Stem about 1 foot high. Umbels on long stalks without involucre; *flowers* small, white; *calyx* obsolete; *carpels* 5, with filiform ridges.

Habitat.—Levant and Egypt; extensively cultivated in Europe.

Description of Drug.—Two or three varieties have been produced by cultivation, the Spanish being the smallest, and usually preferred. In general appearance **anise resembles conium very much,** but it is distinguished from the latter in being usually longer and more

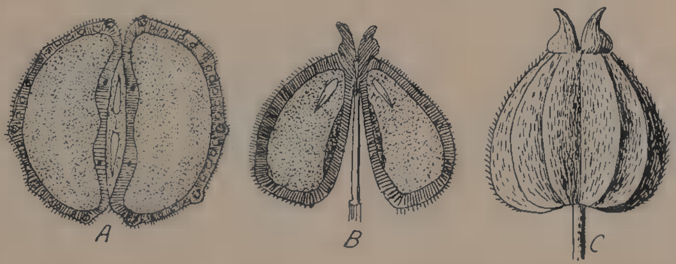

Fig. 112.—*Anisum.* *A.* Transverse section. *B.* Longitudinal section. *C.* Fruit (enlarged).

ovate, the mericarps, which usually adhere together, having their five ribs more or less hairy and not jagged, and having about 15 oil tubes, of which conium has none; **odor** fragrant; **taste** aromatic, sweetish. The fruit is often accompanied with its adhering short peduncle.

Powder.—Dull brownish. Characteristic elements: Parenchyma of endosperm with proteid granules and oil globules; reddish-brown parenchyma tissue inclosing oil glands (Vitæ); sclerenchymatous cells, short, with simple pores (inner epidermis of pericarp is very characteristic); one-celled trichomes and crystals of calcium oxalate also present.

Constituents.—Volatile oil ($1\frac{1}{2}$ to 3 per cent.).

Action and Uses.—Stimulant and aromatic carminative. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

228 **a. OLEUM ANISI,** U. S.—A colorless or pale yellow volatile oil, having the aromatic odor and taste of the fruit; neutral in reaction; sp. gr. 0.98 to 0.99, depending upon age. Dose: 5 ♏ (0.3 Cc.).

CONSTITUENTS.—It contains a slight quantity of a light hydrocarbon oil, but principally **anethol,** $C_{10}H_{12}O$, which is present in both liquid (liquid anethol) and solid form (anise camphor); by oxidation this anethol is converted into **anisic acid;** anethol is the principal constituent also of fennel and star anise, the most of the commercial anise oil being derived from the last-named fruit.

Preparation of Anethol.—Obtained by fractional distillation; by oxidation is converted into anisic acid.

OFFICIAL PREPARATIONS.

Aqua Anisi (0.2 per cent.), ...	Dose: 4 fl. dr. (16 Cc.).
Spiritus Anisi (10 per cent.), ...	90 ♍ (6.0 Cc.).
Spiritus Aurantii Compositus (0.5 per cent.).	
Tinctura Opii Camphorata (0.4 per cent.),.......	2 fl. dr. (8 Cc.).

229. FŒNICULUM.—FENNEL.

FENNEL. *Ger.* FENCHEL.

The dried nearly ripe fruit of **Fœnic'ulum vulga're** Miller.

BOTANICAL CHARACTERISTICS.—Stem somewhat furrowed, 3 feet high. *Leaves* much compounded, cut into fringe-like segments. Umbels with 6 to 8 rays, without involucre or involucel.

HABITAT.—Chiefly imported from Germany, although the cultivated plants in the gardens of this country partially supply the market.

DESCRIPTION OF DRUG.—Varying in size, the longest often being 12 mm. ($\frac{1}{2}$ in.) in length; oblong, terete, a cross-section showing a nearly circular surface; the mericarps are usually separated, however, and slightly curved, their surface dark brown and smooth, with the exception of the five prominent, filiform, lighter colored ribs, the two lateral ones rather broader; in each depression is one oil tube, and on the flat side or commissure there are two. There are two prominent varieties: Saxon, or German, about 4 mm. ($\frac{1}{6}$ in.) long, dark brown, usually in half-fruits without foot-stalks. The other (Roman) is about 12 mm. ($\frac{1}{2}$ in.) in length, lighter brown, with more prominent ribs, and often in the whole state and furnished with foot-stalk. Both, however, are about the same in aromatic properties, and have a warm, sweet, aromatic taste. Bitter fennel, from a wild plant of Southern France, is a small fruit, bitter and spicy. Indian fennel (6.7 mm. in length), anise-like odor; used in the preparation of compound infusion of senna (2 per cent.).

Powder.—Yellowish-brown. Characteristic elements: Parenchyma of endosperm colorless, thick, porous walls (3 to 6 μ in diam.), and oil globules; parenchyma of middle layer of pericarp, large, brown cells elongated, some thick cell walls, or reticulate, bordering vittæ in fragments; aleurone (1 to 2 μ in diam.).

CONSTITUENTS.—From 2.5 to 4 per cent. of volatile oil, almost chemically identical with that of anise. It contains phellandrene, $C_{10}H_{16}$.

ACTION AND USES.—Stimulant, carminative, stomachic, corrective. Dose: 8 to 30 gr. (0.5 to 2 Gm.), in infusion or powder.

229 a. **OLEUM FŒNICULI,** U. S.—A colorless or pale yellow

FIG. 113.—*Fœniculum capillaceum*—Branch and fruit entire and in cross-section.

volatile oil, having a specific gravity of 0.96. It usually solidifies at from 5° to 10° C. (41° to 50° F.). It has essentially the same constituents as the oil of anise. Stimulant and carminative, and a corrective of harsh, purgative preparations. Dose: 1 to 5 ♏ (0.06 to 0.3 Cc.).

OFFICIAL PREPARATIONS.

Aqua Fœniculi (0.2 per cent.), ...Dose:	$\frac{1}{4}$ to 1 fl. oz. (8 to 30 Cc.).
Pulvis Glycyrrhizæ Compositus (0.4 per cent.), ...	$\frac{1}{2}$ to 2 dr. (2 to 8 Gm.).
Spiritus Juniperi Compositus (0.05 per cent.), ...	1 to 4 fl. dr. (4 to 15 Cc.).

230. CONIUM.—CONIUM.

POISON HEMLOCK. *Ger.* SCHIERLINGSFRÜCHTE.

The full-grown, but unripe fruit of **Con'ium macula'tum** Linné, carefully dried and preserved, and yielding, by official assay, not less than 0.5 per cent. of coniine. It should not be kept longer than two years.

BOTANICAL CHARACTERISTICS.—*Stem* 2 to 6 feet high, dotted with dull purple spots. *Leaves* large, shining, tripinnate, with long, furrowed petioles, sheathing at the base. *Umbels* numerous, with one-sided involucels of 3 or 4 ovate or lanceolate bracts, united at base; *flowers* white.

HABITAT.—Europe and Asia; naturalized in North America.

DESCRIPTION OF DRUG.—Gathered when full grown but yet green, the yield of alkaloid being greatest at this time. Small, roundish-ovate, laterally compressed, grayish-green. The mericarps, which are often

FIG. 114.—Fruit of Hemlock (*Conium maculatum*).

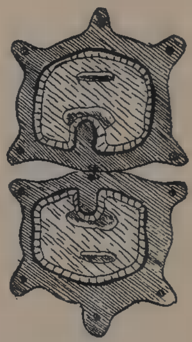

FIG. 115.—Cross-section of the fruit of *Conium maculatum*, 20 diam.

separated, have **five jagged ribs but no oil-tubes;** the flat side or commissure is deeply furrowed, giving to a transverse cut surface a reniform outline. **Almost odorless; taste disagreeable and somewhat acrid;** when triturated with a solution of KOH, conium emits the peculiar, mouse-like odor characteristic of the alkaloid, coniine, which is developed thereby. The total alkaloids in the fruit may reach as high as 3.5 per cent., rapidly diminishing as it ripens. The U. S. P. requires not less than 0.5 per cent. of coniine in the drug, which is unfit for use when more than two years old.

Powder.—Pale yellowish-brown. Characteristic elements: Parenchyma of endosperm, rather thick-walled with oil globules and aleurone (4 to 7 μ in diam.); aggregate calcium oxalate (1 to 2 μ in diam.); other parenchyma with starch and chloroplastids; sclerenchyma, from fruit and stalk with bast fibers, long and

thin-walled, with numerous pores; collenchymatous cells from mericarp, yellowish, nearly isodiametrical, irregularly thickened.

CONSTITUENTS.—The liquid alkaloid, **coniine,** $C_8H_{17}N$ (the active constituent), **methyl coniine,** $C_8H_{16}(CH_3)N$ (also liquid), conhydrine and its isomer, pseudoconiine. Coniine is a yellowish, oily, volatile liquid (sp. gr. 0.88), very acrid, and of a strong, mouse-like odor; it is strongly basic, and is combined in the fruit with conhydric acid, from which it may instantly be freed and its odor developed in the fruit by rubbing with potassa, as noted above; its action is that of a paralyzant to the motor nervous system. Methyl coniine resembles it in action. Conhydrine is in iridescent scales, melting at 120.6° C.

Preparation of Coniine.—Liberated from drug by distilling it with alkali. Methyl coniine and conhydrine is likely to come over with it.

Separation of Conhydrine from Coniine.—Reduce the temperature of the oily liquid containing the two by a freezing mixture. Recrystallize from ether. Occurs in iridescent scales, less poisonous than coniine.

ACTION AND USES.—Conium is narcotic and sedative; its principal action is as a **paralyzant to the motor nerves.** Dose: 3 to 5 gr. (0.2 to 0.3 Gm.). The alkaloid coniine is an active poison, the dose being from $\frac{1}{4}$ to $\frac{1}{2}$ ♏ (0.0164 to 0.0324 Cc.); dose of the hydrochlorate is probably about $\frac{1}{6}$ gr. (0.01 Gm.).

OFFICIAL PREPARATIONS.

Extractum Conii (U. S. P., 1890),..	Dose: $\frac{1}{2}$ to 2 gr. (0.0324 to 0.13 Gm.).
Fluidextractum Conii,............	1 to 5 ♏ (0.065 to 0.3 Cc.).

231. **CONII FOLIA**.—HEMLOCK LEAVES. Grayish-green, thin, smooth, from 100 to 300 mm. (4 to 12 in.) long, twice or thrice decompound, with oblong-lanceolate, acute, sharply serrate divisions; petiolate, the petiole hollow; odor mouse-like; taste disagreeable. They contain coniine in very small quantity, and are less active than the fruit, but used for the same purposes —as an anodyne and antispasmodic for controlling maniacal excitement and spasmodic affections, such as whooping-cough, etc. Dose: about 5 gr. (0.3 Gm.).

232. CARUM.—CARAWAY.

CARAWAY. *Ger.* KÜMMEL.

The dried fruit of **Car'um car'vi** Linné.

BOTANICAL CHARACTERISTICS.—A biennial 2 feet in height, with bipinnate *leaves.* The *umbel* rarely involucrate; *flowers* consisting of 5 obcordate, small, white *petals; carpels* with 5 filiform ridges; stylopodium (the disk-like expansion of the receptacle) depressed. *Fruit* brownish, oblong, slightly curved.

HABITAT.—Asia; introduced into America.

DESCRIPTION OF DRUG.—The mericarps, which are usually separated, are about 4 to 5 mm. ($\frac{1}{6}$ to $\frac{1}{5}$ in.) in length, tapering somewhat at the

ends. Surface dark brown, smooth, with the exception of the **five lighter colored,** filiform **ribs,** between which are the six large, easily visible oil-tubes. A cross-section shows the pentangular seed and oil-tubes. **Odor and taste** aromatic, agreeable. The U. S. P. requires not more than 8 per cent. of ash. "Drawn fruits": This name has been applied to a form of adulterated caraway—a partially exhausted fruit, whereby they have been deprived of a portion of the volatile oil. It is said that "Dutch seed" of fair quality should give over 5 per cent. of volatile oil. Exhausted fruits have been found to contain but 1.5 to 1.9 per cent. of oil. They are of much darker color than the genuine. The American seed is slightly smaller than the German. The seed cultivated in Northern Germany is too deficient in essential oil for profitable distillation, but it has a fine appearance.

Powder.—Dark brown. Characteristic elements: Parenchyma of pericarp thin-walled, yellowish; parenchyma of endosperm with fat and proteid; aleurone granules (2 to 3 μ in diam.); sclerenchyma from pericarp with few bast fibers, thick-walled, and with numerous simple pits, slightly lignified; resin in yellowish particles; oil cells in fragments of light yellow color.

CONSTITUENTS.—Volatile oil 5 to 7 per cent., consisting of carvone (carvol, $C_{10}H_{14}O$) about 50 per cent.; readily soluble in alcohol, slightly soluble in water.

ACTION AND USES.—Stimulant, stomachic, and carminative, and an adjuvant. Dose: 15 to 30 gr. (1 to 2 Gm.).

OFFICIAL PREPARATION.

Tinctura Cardamomi Composita (1.2 per cent.), ... Dose: 1 to 4 fl. dr. (4 to 15 Cc.).

232 a. **OLEUM CARI,** U. S.—A limpid, colorless or pale yellow volatile oil, specific gravity 0.92, with an aromatic odor and taste, becoming acrid and of a higher specific gravity when exposed. It consists of two portions, a light hydrocarbon, **carvene,** identical with limonene, and a heavy oil, **carvol,** isomeric with thymol.

ACTION AND USES.—Stimulant, stomachic, carminative, and adjuvant. Dose: 1 to 10 ♏ (0.065 to 0.6 Cc.).

OFFICIAL PREPARATION.

Spiritus Juniperi Compositus (0.05 per cent.), ... Dose: 2 to 4 fl. dr. (8 to 15 Cc.).

233. CORIANDRUM.—CORIANDER.

CORIANDER. *Ger.* KORIANDER.

The dried ripe fruit of **Corian'drum sati'vum** Linné.

BOTANICAL CHARACTERISTICS.—An annual herb about two feet high, with an offensive, bedbug-like odor, with smooth stem and bipinnate *leaves*. *Calyx*

5-toothed; *petals* obcordate (the exterior ones bifid), white, often with a pink tinge. *Capsules* with primary ridges obsolete, the four secondary ones prominently keeled. *Fruit* globose; *seed* covered with a loose membrane.

HABITAT.—Italy; cultivated in all parts of Europe and United States.

DESCRIPTION OF DRUG.—**Almost globular,** about 3 mm. ($\frac{1}{8}$ in.) in diameter, slightly pointed at the apex (style) and with the persistent calyx-teeth around the pedicel-scar at the base. The two concave, hemispherical **mericarps are closely united at the edge** by the woody pericarp; their outer surface is pale yellowish-brown, sometimes purplish-tinted, with five primary ribs merely indicated by wavy, slightly raised lines, and four more prominent secondary ribs. The interior of the fruit is a lenticular cavity. Odor fragrant (the odor of the fresh plant and fruit is fœtid, resembling bedbugs); **taste** aromatic.

FIG. 116.—*Coriandrum sativum*—Whole fruit and cross-section.

Powder.—Light brown. Characteristic elements: Parenchyma of endosperm, small cells with aleurone, oil globules, calcium oxalate; other parenchyma yellowish, thin-walled; sclerenchyma with bast fibers, yellowish, thick-walled, lignified and irregularly curved; oil cells in fragments, light yellow; inner epidermal cells, long and narrow.

CONSTITUENTS.—**Volatile oil,** $\frac{1}{2}$ to 1 per cent., containing coriandrol, $C_{10}H_{18}O$, also dextropinene, fat, mucilage, ash.

ACTION AND USES.—Feeble aromatic and stimulant; mostly used as an aromatic addition to, or a **corrective** of, purgative preparations. Dose: 8 to 30 gr. (0.5 to 2 Gm.)

233 a. **OLEUM CORIANDRI.**—An almost colorless or yellowish volatile oil with the characteristic aromatic odor and taste of the fruit; specific gravity 0.87 to 0.88; neutral in reaction. It is one of the most stable of the volatile oils in its power of resisting oxidation when exposed. It consists mainly of d-linalol or coriandrol, $C_{10}H_{18}O$. Stimulant and carminative, like the other aromatic oils. Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.).

OFFICIAL PREPARATIONS.

Spiritus Aurantii Compositus (2.0 per cent.), ... Dose:	1 to 4 fl. dr. (4 to 15 Cc.).
Confectio Sennæ (0.5 per cent.), ...	1 to 3 dr. (4 to 12 Gm.).
Syrupus Sennæ (0.5 per cent.), ...	1 fl. dr. (4 Cc.).

234. **ANETHUM.**—DILL FRUIT OR DILL SEED. The fruit of **Ane'thum graveo'lens** Linné, an herb of Levant and Southern Europe. Oval-oblong, usually separated into the two thin mericarps; these have a smooth brown surface, with five ribs, the two lateral ones expanded into a **lighter colored, membranous wing surrounding the fruit;** oil-tubes six, two on the concave inner face and one in each interval between the ribs; odor and taste caraway-like, depending upon the volatile oil, the heavy portion of which is doubtless carvol. Stimulant, carminative, and stomachic. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

234 a. **OLEUM ANETHI.**—Pale yellow, with the characteristic odor of the fruit, and a pungent, sweetish, acrid taste. It is official in the British Pharmacopœia, where it is sometimes used to prepare dill-water.

235. **APIUM.**—CELERY FRUIT. From **A'pium graveo'lens** Linné, the common celery of our gardens, native to Levant and Southern Europe. Roundish-ovate, very small, brown cremocarps, generally separated into the two mericarps, which have five ribs and about six oil-tubes. They contain a volatile oil and a yellowish liquid principle, **apiol,** an oleoresinous substance, but somewhat analogous to the fixed oils; this apiol is chiefly extracted for medicinal use from parsley, however; it is used as an emmenagogue in doses of 10 to 15 ♏ (0.6 to 1 Cc.).

Preparation of Apiol.—The simplest process for its separation is to exhaust the fruit with petroleum-benzene, evaporate the solvent, and treat the residue with strong alcohol. On evaporation, the apiol remains. A process resulting in a pure, almost colorless apiol is published in "Pharm. Archiv," Feb., 1899. Dose: 7½ to 23 gr. (0.5 to 1.5 Gm.).

Celery is stimulant, antispasmodic, and carminative. Dose of fl'ext.: 5 to 15 ♏ (0.3 to 1 Cc.).

236. **AJOWAN.**—The fruit of **Ca'rum ajow'an** Bentham and Hooker. *Habitat:* Southern Asia and Egypt. Ovate, somewhat compressed laterally, about 2 mm. ($\frac{1}{12}$ in.) long, with a rough, grayish-brown surface; mericarps usually separated, containing six oil-tubes. The large fruits much resemble those of common parsley, but are readily distinguished from them and other small umbelliferæ by their odor and very rough surface. **Odor** thyme-like; taste pungent and aromatic, due to a volatile oil, 5 to 6 per cent., which consists of a terpene, cymene, and the stearopten, **thymol.** Ajowan is one of the commercial sources of this stearopten. Oil of ajowan, when freshly distilled, is colorless, but soon acquires a slightly yellow tinge. It has an acrid, burning taste. Carminative, stomachic, having the same properties as thymol (see below). Dose: 10 to 30 gr. (0.6 to 0.2 Gm.).

237. THYMOL.

THYMOL. *Ger.* THYMIANSÄURE.

A phenol, $C_{10}H_{13}OH$, obtained by fractional distillation of oils from **Thymus vulgaris, Carum ajowan,** and **Monarda punctata.** That portion coming over at 392° F. (200° C.) is separately collected and subjected to freezing, when thymol crystallizes out; or by distilling off a greater part of the light oils or hydrocarbons and obtaining the thymol from the remaining heavier liquid by the use of caustic soda and HCl.

DESCRIPTION.—Small, colorless scales or large, translucent crystals of the hexagonal system having a **thyme-like odor** and pungent taste, somewhat caustic to the lips. It melts at about 50° C. (122° F.), but

does not crystallize again until a much lower temperature is reached. Sparingly soluble in water (1 : 1200), but dissolves in less than its own weight of alcohol, ether, or chloroform. The crystals have a specific gravity of 1.069, but the melted liquid is lighter than water. Chemically, thymol is considered as isopropyl-meta-cresol (C_6H_3.-CH_3.OH.C_3H_7), and is closely related to carvacrol, which is regarded as isopropyl-ortho-cresol; the two differing in the relative position of the hydroxyl group. (**Liquor Antisepticus,** U. S. P. 1900.)

ACTION AND USES.—Stimulant and **powerful antiseptic,** generally applied externally in ointment or lotion, or in a spray. Internal dose: 1 to 2 gr. (0.065 to 0.13 Gm.).

238. **PETROSELINUM.**—PARSLEY. The root of **Petroseli'num sati'vum** Hoffman, native to Southern Europe, but cultivated extensively as a common garden plant. A tapering root from 100 to 200 mm. (4 to 8 in.) long, and about 12 mm. (½ in.) thick; externally yellowish or light brown, marked with close annular rings above and longitudinal wrinkles at the lower end; **fracture** short, showing a thick bark dotted with resin cells, and a porous, pale yellow wood, with very irregular, white medullary rays. When fresh, it has a strong, aromatic odor, but is only faintly so when dry; taste sweetish, slightly aromatic. It is the chief source of **apiol** (also found in celery), a yellowish liquid somewhat analogous to the fixed oils, given as an emmenagogue in doses of 10 to 15 ♏ (0.6 to 1 Cc.). The root is given in infusion as a carminative, and as a laxative and diuretic in nephritic and dropsical affections. Dose: 30 to 60 gr. (2 to 4 Gm.).

238 **a. THE FRUIT** is ovate, about 2 mm. ($\frac{1}{12}$ in.) long, with a greenish or brownish-gray surface, the mericarps usually separated. It contains the same principal ingredients, and is used for about the same purposes as the root. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

238 **b. APIOL** (L. *apinum*, parsley, + ol), an oleoresinous liquid, heavier than water, of a persistent odor, distinct from the plant, and an acrid, pungent taste; from certain umbelliferous fruits, chiefly parsley "seed." A crystalline compound, $C_{12}H_{14}O_4$, a purified *apiol* (parsley camphor) is obtainable. Dill oil yields a liquid *apiol* which has the same composition as the crystallizable *apiol* from the parsley. (See also 235.)

239. **PHELLANDRIUM.**—WATER DROPWORT. FIVE-LEAVED WATER HEMLOCK. The fruit of a European aquatic plant, **Œnan'the phellan'drium** Lamarck. From 2 to 3 mm. ($\frac{1}{12}$ to $\frac{1}{8}$ in.) in length, terete, oblong, narrowed at one end, and crowned with the stylopodium; yellowish-brown or blackish-brown in color; taste aromatic, slightly acrid; odor strong, somewhat caraway-like, but disagreeable. Its aromatic properties depend upon a volatile oil, but there are indications of a narcotic alkaloid, **possibly coniine,** as the characteristic mouse-like odor is developed when the powdered seeds are rubbed with a solution of potassa. Slightly narcotic, stimulant, but more particularly used in chronic affections of the air-passages, as bronchitis, etc. Dose of powder about 5 gr. (0.3 Gm.), cautiously increased.

240. **CUMINUM.**—CUMIN SEED. The fruit of **Cumi'num cym'inum** Linné. *Habitat:* Egypt; cultivated in Southern Europe. Resembles caraway, but may be distinguished by its entirely different, peculiar, heavy odor, and in being whole fruits and not half-fruits, as in the latter; surface brown, rough, and hairy; ribs 18, oil-tubes 6; taste aromatic, bitterish, disagreeable. It contains a volatile oil, often used as a carminative, which consists of three different oils (two hydrocarbons and cuminol). Cumin is much stronger

as a stimulant than the other umbelliferous fruits. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

241. **CAROTA.**—Carrot Fruit. From wild plants of **Dau'cus caro'ta Linné.** *Habitat:* United States and Europe. Light, oval-oblong fruits, dorsally compressed; mericarps usually united, brownish, each with five hairy primary ribs and four more prominent secondary ones **beset with long, white bristles;** odor aromatic; taste warm, bitterish. Aromatic stimulant, diuretic. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

242. **ANGELICA ATROPURPUREA.**—American Angelica. (Root.) This highly aromatic root was official in the U. S. P., 1860–'70. It is similar to—

243. **ANGELICA, A. OFFICINALIS.**—European or Garden Angelica. (Root.) The aroma is due to a fragrant volatile oil. Also contains **angelic acid** (also found in sumbul), which has an action on the nerves. *Description:* Root-stock 5 to 10 cm. (2 to 4 in.) long, 2.5 to 5 cm. (½ in.) thick, crowned with remnants of leaf-bases, rather thick bark, curved yellowish, porous wood-wedges, a whitish pith, spongy, especially in root-branches, radiating lines of large resin-ducts in the bark, bast rays destitute of bast fibers. Aromatic stimulant, stomachic, and carminative. Dose: 30 to 60 gr. (2 to 4 Gm.).

244. ASAFŒTIDA.—Asafetida.

ASAFETIDA. *Ger.* STINKASANT.

A gum-resin obtained from the root of **Feru'la fœ'tida** Regel, and other species of Ferula.

Botanical Characteristics.—A gigantic herbaceous plant, 10 feet high, with radical *leaves* 18 inches long, bipinnate; *calyx* nearly obsolete, consisting of 5 minute points. *Fruit* broadly elliptical, thin, foliaceous, with dilated border; vittæ inconspicuous.

Source.—This plant, and other species from which commercial asafetida is procured, grows in Western Thibet, Kashmir, Persia, Turkestan, and Afghanistan. The plant is cut off at the root, and the milky juice exuding is allowed to harden, the sun being excluded by branches and leaves thrown over the cut surface; when it has solidified it is scraped off, and another slice of the root is cut off to expose a fresh surface, this operation being continued until the root is exhausted.

Description of Drug.—Masses composed of white tears of various shapes and sizes, imbedded in a brown, sticky mass, along with vegetable trash and earthy impurities. These masses are at first soft, but harden on exposure, the tears breaking with a conchoidal fracture, at first milk-white, but gradually turning pink, and at last brown. It resembles galbanum very much in appearance, but is easily distinguished by its **strong, disagreeable, alliaceous odor,** due to a sulphuretted volatile oil present to the extent of 3 to 9 per cent. On adding ammonia to a decoction of the sublimated resin, a blue fluorescence is exhibited. Taste acrid, bitter, and alliaceous.

VARIETIES.—Besides the above-described variety, the amygdaloid, which is the most common, there are other forms in which it enters the market:

Liquid asafœtida is a permanent, syrupy liquid, white, turning brown on exposure.

Asafœtida in tears is the purest variety.

Stony asafœtida, never used medicinally, consists of pieces of gypsum or other earthy material coated with a thin layer of the milk-juice.

CONSTITUENTS.—The greater part of asafœtida consists of a gum (20 to 30 per cent.) and resin (50 to 70 per cent.). These, with the volatile oil (3 to 9 per cent.), form with water a milky emulsion. The resin is regarded by Tschirch as the ferulic ester of asaresinotannol, $C_{24}H_{35}O_5$, which, by sublimation, yields umbelliferone. There is also contained in the drug vanillin 0.06 per cent., ferulic acid, $C_{10}H_{10}O_4$, 1.28 per cent. The resin, when fused with KOH, yields resorcin and protocatechuic acid. The mineral impurities often amount to 40 per cent., especially in that imported from Herat, where it is adulterated with red clay.

For an exhaustive treatise on Gum Resins, etc., the student is referred to "Analysis of Resins, Balsams and Gum Resins, Their Chemistry and Pharmacognosis," by Carl Dietrich (Scott, Greenwood & Co., London).

ACTION AND USES.—Asafœtida combines the properties of a stimulating **antispasmodic** with those of an efficient expectorant, making it a valuable remedy in spasmodic affections of the respiratory tract, as whooping-cough, asthma, etc. It is also a **laxative,** especially useful in cases of flatulence. Dose: 5 to 8 gr. (0.3 to 0.5 Gm.).

OFFICIAL PREPARATIONS.

Emulsum Asafœtidæ (4 per cent.), ...Dose:	2 to 4 fl. dr. (8 to 15 Cc.).
Tinctura Asafœtidæ (20 per cent.),....	10 to 40 ♏ (0.6 to 2.6 Cc.).
Pilulæ Asafœtidæ (each pill containing about 3 gr. of asafœtida, with soap as an excipient),......................	2 to 5 pills.

245. **GALBANUM.**—GALBANUM. A gum-resin imported from Persia, but the botanical source of which is not definitely decided; it is generally considered, however, as a spontaneous exudation from **Feru'la galbani'flua** Boissier et Buhse, and other species of Ferula, large plants growing in that region. It is usually met with in pale yellow or brownish tears, ranging in size from a pea to a hazelnut, occasionally separate and with a shining, varnished surface, but more generally agglutinated into a more or less hard mass by means of a darker, yellowish-brown, sometimes greenish, substance. In winter this mass has the consistence of firm wax, but in the heat of summer it becomes soft and sticky; odor balsamic; taste acrid and bitter.

CONSTITUENTS.—Besides gum and resin, it contains the interesting principle, **umbelliferone** (common to many umbelliferous plants), acicular crystals, producing a brilliant blue fluorescence on the addition of an alkali.

ACTION AND USES.—Stimulant, expectorant, and antispasmodic. Dose: 5 to 8 gr. (0.3 to 0.5 Gm.).

246. **AMMONIACUM.**—GUM AMMONIAC. A gum-resin exuding from **Dore'ma ammoni'acum** Don. Off. U. S. P., 1890. Roundish tears varying in size from 1.5 to 12 mm. ($\frac{1}{16}$ to $\frac{1}{2}$ in.) in diameter, externally yellow or pale yellowish-brown. When warm it is of the consistence of wax, but it becomes brittle when cold, breaking with a milk-white, waxy fracture, translucent at the edges; odor balsamic, stronger on heating; taste acrid, bitter, and nauseous. Lump ammoniac is an inferior quality in which the tears are agglutinated. Cake ammoniac is a very impure, dark-colored, resinous mass exuding from the roots; imbedded in it are a few tears and much vegetable and earthy trash; it is not used internally. *Constituents:* Volatile oil, gum resembling acacia, resin (about 70 per cent. composed of two, one acrid resin and one indifferent resin); it yields no umbelliferone. By fusing with KOH, yields protocatechuic acid and resorcin, $C_6H_6O_2$. Among the derivatives of the acid resin are salicylic acid, ammoresinotannol, etc. Similar to asafœtida—stimulating expectorant, antispasmodic and laxative—but less powerful. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

Emulsum Ammoniaci (4 per cent.), U. S. P., 1890, ... Dose: $\frac{1}{2}$ to 1 fl. oz. (15 to 30 Cc.).
Emplastrum Ammoniaci cum Hydrargyro (72 per cent., with mercury oleate of mercury, dilute acetic acid, and lead plaster), U. S. P., 1890.

247. SUMBUL.—SUMBUL.

MUSK ROOT. *Ger.* SUMBULWURZEL.

The dried root of **Feru'la sum'bul** Hooker filius (?).

BOTANICAL CHARACTERISTICS.—*Root* fusiform; perennial stem 8 to 10 feet high. *Fruit* oblong-ovate, monocarpous. When punctured, the branches yield an angelica-flavored milk-juice.

HABITAT.—Regions north and east of British India.

DESCRIPTION OF DRUG.—**Transverse segments** about 10 to 50 mm. ($\frac{2}{5}$ to 2 in.) long, and 25 mm. (1 in.) thick. They have a **dusky-brown,** wrinkled bark, just beneath which is a whitish, spongy, parenchymatous layer, under the microscope dotted with brown, translucent, resinous exudations from large resin-ducts. **The brownish-yellow interior** is a **spongy mass** consisting of coarse fibers, easily separable, and indiscriminately mixed and twisted with the medullary rays; fracture short and fibrous. **Odor musk-like;** taste sweetish at first, becoming bitter and balsamic, and leaving a sensation of warmth in the mouth and throat. E. M. Holmes refers to the inferior quality of this root of late years. He recommends that the true root be cultivated, which he thinks possible in temperate and mountainous districts in the colonies or in ordinary gardens and fields of England. The true root has a strong, persistent, musky odor, which the roots of recent importation do not have.

Powder.—Brown. Characteristic elements: Parenchyma of cortex, spongy, with irregular masses of brownish resin, starch, spherical (4 to 15 μ in diam.);

parenchyma just below cork, elongated cells with reddish-brown coloring-matter, ducts, large, brown with short, reticulate, scalariform, simple pores; wood fibers broad, pitted; brown cork abundant.

CONSTITUENTS.—**Sumbulic or angelic acid,** $C_5H_8O_2$, a small quantity of **valerianic acid,** $C_5H_{10}O_2$, and a small percentage of **bluish** volatile oil, to which, however, its odor is not due, but to two balsamic resins, or probably to some principle connected with them not yet isolated. The oil contains umbelliferone, $C_9H_6O_3$.

ACTION AND USES.—**Antispasmodic** (due to the angelic and valerianic acids contained), stimulant, and tonic. Dose: 15 to 30 gr. (1 to 2 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Sumbul,............Dose: 30 ♍ (2.0 Cc.).
Extractum Sumbul, ... 5 to 15 gr. (0.3 to 1 Gm.).

248. **IMPERATORIA.**—MASTERWORT. The root of **Imperato'ria ostru'thium** Linné. *Habitat:* Southern Europe. A conical root with a dark brownish-gray, annulated and tuberculated bark, inclosing a whitish wood-circle and a resin-dotted central pith; odor angelica-like; taste pungent and bitter. It is a stimulant aromatic, but is rarely used in this country.

249. **LASERPITIUM.**—WHITE GENTIAN. The root of **Laserpi'tium latifo'lium** Linné. *Habitat:* Central Europe. Somewhat conical, wrinkled and annulated above, branched below; wood whitish, porous, deprived of the brown, corky layer; aromatic and bitter. Used as a tonic and stimulant. Dose: 15 to 60 gr. (1 to 4 Gm.).

250. **LEVISTICUM.**—LOVAGE. The root of an aromatic European herb, **Ligus'ticum levis'ticum** Linné. This is thick, sparingly beset with fibers, and has an annulate, reddish-brown bark, inclosing a porous yellow wood; it has an aromatic odor resembling that of angelica, and a sweetish, aromatic, and pungent taste, somewhat bitter. Its medicinal properties are similar to those of angelica, being used as an aromatic stimulant and carminative, and as an adjuvant to tonic mixtures. Dose: 8 to 30 gr. (0.5 to 2 Gm.), in infusion.

The root of **Ligus'ticum filici'num,** Osha or Colorado Cough Root, has enjoyed some notoriety as an expectorant.

251. **PIMPINELLA.**—PIMPERNEL. The root of **Pimpinel'la saxifra'ga** Linné. *Habitat:* Europe. Diaphoretic, diuretic, and stomachic. It has also been employed in chronic catarrh, asthma, dropsy, amenorrhœa, etc., and as a masticatory in toothache. Dose: 15 to 30 gr. (1 to 2 Gm.), in infusion or powder.

252. **THAPSIA GARGANICA** Linné.—(Root.) Used chiefly as a counter-irritant in rheumatism, gout, bruises, etc.

253. **CICUTA MACULATA.**—AMERICAN WATER-HEMLOCK. WILD PARSNIP. The root and leaves of **Cicu'ta macula'ta** Linné. Poisonous, sedative, narcotic; **resembles conium in action** and has been used in its stead, but the two drugs should not be confounded when conium is prescribed, as it sometimes is, by its old name, cicuta. Dose: 3 to 5 gr. (0.2 to 0.3 Gm.). Children have been poisoned by eating the fresh root, which resembles parsnip in taste and smell.

254. **ERYNGIUM AQUATICUM** Linné.—WATER ERYNGO. RATTLESNAKE'S MASTER. *Habitat:* United States. (Root.) Diaphoretic and expectorant, and has been used as a substitute for senega. Dose of fluidextract: 20 to 40 ♍ (1.3 to 2.6 Cc.).

255. **OSMORRHIZA LONGISTYLIS** De Candolle.—SWEET CICELY. *Habitat:* United States and Canada. (Root.) Aromatic, stomachic, carminative, and expectorant. It contains a volatile oil identical with oil of anise. Dose: 1 to 2 dr. (4 to 8 Gm.).

ARALIACEÆ.—Ginseng Family.

Synopsis of Drugs from the Araliaceæ.

A. *Root.*
Panax, 256.

B. *Rhizome.*
Aralia Nudicaulis, 257.
Aralia Racemosa, 257.
Aralia Hispida, 258.

256. **PANAX.**—GINSENG. (Official, 1840–1880.) The root of **Pa'nax quinquefo'lium** Willdenow. Collected in Ohio, West Virginia, Minnesota, etc., and exported to China, where, from its fancied resemblance to the human figure, it is supposed to possess miraculous powers in preventing and curing diseases, and where at one time it was valued at its weight in gold. It has, however, little medicinal properties except as a demulcent and aromatic stimulant; not used extensively in medicine. It is a soft, yellowish-white, fusiform root, about the thickness of the finger, with two or three equal branches below. A **cross-section** shows a hard central portion, surrounded by a thick, soft, white inner cortical layer; with thin bark, containing numerous reddish resin-cells; wood-wedges narrow; medullary rays broad; odor feeble; taste sweet, slightly aromatic. The sweet principle is **panaquilon,** $C_{12}H_{25}O_9$.

Preparation of Panaquilon.—Concentrate the cold infusion to a syrup, precipitate by concentrated solution of sodium sulphate, wash the precipitate thoroughly with the saline solution, then treat with alcohol, which dissolves the principle; evaporate to dryness.

257. **ARALIA NUDICAULIS** Linné.—FALSE SARSAPARILLA. WILD LICORICE. *Habitat:* North America. (Rhizome.) Horizontal, often 300 mm. (12 in.) in length, and about the thickness of the little finger; it has a yellowish-brown, wrinkled, and annulate bark, inclosing a yellow wood and spongy pith; somewhat aromatic; taste warm, aromatic, and sweetish. The rhizome of **Ara'lia racemo'sa** Linné (American Spikenard) is short, and from 25 to 50 mm. (1 to 2 in.) thick, marked above by prominent stem-scars and beset below with long, branching rootlets; externally pale brown, internally whitish; more aromatic and spicy than *A. nudicau'lis.* Both rhizomes are used extensively in domestic practice as stimulant, diaphoretic, and alterative. Dose: 30 to 60 gr. (2 to 4 Gm.), in infusion. This drug is treated of exhaustively by Alpers and Murray ("Proc. of Pharm. Assoc.," 1897, p. 183).

258. **ARALIA HISPIDA** Ventenat.—DWARF ELDER. *Habitat:* United States. (Rhizome.) Diuretic; used in dropsy, etc. Dose of fluidextract: 1 to 2 fl. dr. (4 to 8 Cc.).

CORNACEÆ.—Dogwood Family.

259. **CORNUS FLORIDA.**—DOGWOOD. The root-bark of **Cor'nus flori'da** Linné. *Habitat:* North America. Appears in pieces of various sizes, generally broken up and more or less curved; about 2 mm. ($\frac{1}{12}$ in.) in thickness when deprived of its brownish-gray cork, as it generally is, with a fawn-colored outer surface; inner surface red, due to the tannin contained, plainly radially striate; **fracture short, whitish,** showing numerous striæ

of brownish-yellow stone cells. Inodorous; taste astringent and bitter, the bitter principle being termed **cornin.** It yields a grayish powder, tinged with red. Tonic and astringent, and almost equal to cinchona as an **antiperiodic** in intermittent fevers. Dose: 10 to 30 gr. (0.6 to 2 Gm.). The barks of two other dogwoods, *Cor'nus circina'ta* (green osier bark or round-leaved dogwood bark) and *Cor'nus serice'a*, are often used.

FIG. 117.—*Cornus florida*—Flowering branch.

260. **GARRYA FREMONTII** Torrey.—CALIFORNIA FEVER BUSH. (Leaves.) Used as a tonic and antiperiodic in chills and fevers. They contain a bitter principle similar to quinine in therapeutic acton. Dose: 15 to 30 gr. (1 to 2 Gm.).

CAPRIFOLIACEÆ.—Honeysuckle Family.

Shrubs, as viburnum, or twining plants, as the honeysuckle, with opposite, exstipulate *leaves*, a gamopetalous *corolla*, and the *fruit* a berry, pod, or drupe. The *calyx-tube* is adherent to the 2- to 5-celled ovary.

Synopsis of Drugs from the Caprifoliaceæ.

A. *Flowers.*
  Sambucus, 261.

B. *Bark.*
  VIBURNUM OPULUS, 262.
  VIBURNUM PRUNIFOLIUM, 263.

C. *Root.*
  Triosteum, 264.

261. **SAMBUCUS.**—ELDER. The dry flowers of **Sambu'cus canaden'sis** Linné. Collected when in full bloom and rapidly dried, the commercial drug being composed of the small, yellowish, somewhat wheel-shaped and shriveled flowers, mixed with a few expanded ones; usually detached from their peduncles, which are mixed with them. They have a sweetish, somewhat bitter taste, and a slight, peculiar, agreeable odor, due to a very small quantity of volatile oil. The European elder (*S. nigra*) resembles *S. canadensis*. *Constituents:* Besides volatile oil, they contain sugar, mucilage, fat, wax, resin, pectin, albuminoids, and probably a little tannin. Stimulant, carminative, and diaphoretic. Dose: 30 to 60 gr. (2 to 4 Gm.).

FIG. 118.—*Viburnum opulus*—Flowering branch and fruit.

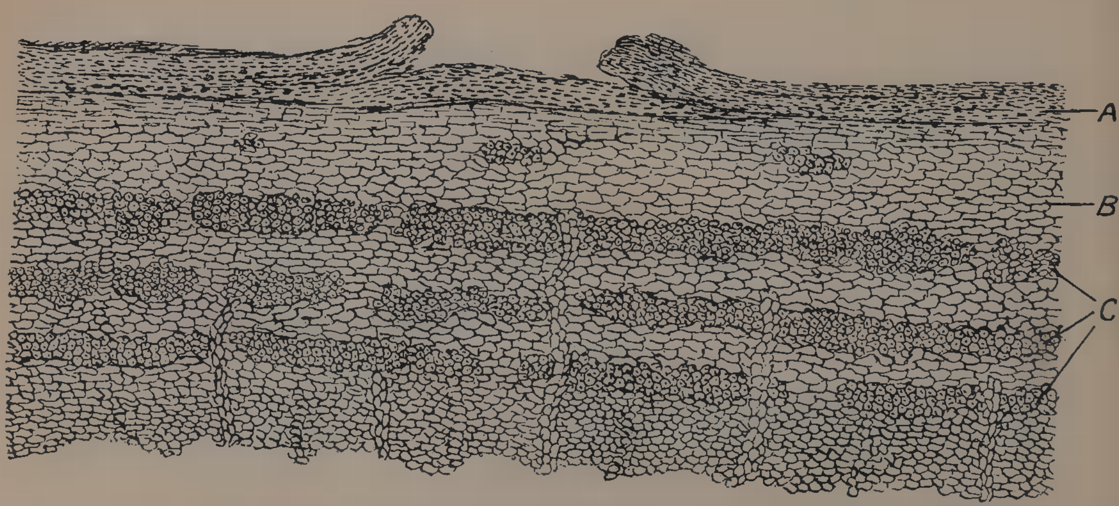

FIG. 119.—*Viburnum opulus*—Bark of stem, cross-section. *A*. Cork. *B*. Cortical parenchyma. *C*. Group of bast fibers in cortical parenchyma.

262. VIBURNUM OPULUS.—Cramp Bark.

HIGH BUSH CRANBERRY. *Ger.* WASSERHOLDERRINDE.

The dried bark of **Vibur'num op'ulus** Linné.

Botanical Characteristics.—*Leaves* palmate, 3- to 5-ribbed, 3-lobed, the petioles bearing two glands at base. *Cymes* peduncled. *Fruit* a light red, acid, globose drupe.

Habitat.—North America.

Description of Drug.—Very thin pieces or occasionally quills, with an ash-gray periderm marked with elongated brown warts and black dots in longitudinal lines; it is easily removed from the somewhat reddish-brown surface of the middle layer; the inner surface is white or brownish; fracture uneven, fibrous; inner layer of the bark contains large clusters in the form of elongated bands of bast fibers, associated with but few stone cells. These interrupted bands are separated from one another by narrow medullary rays and, longitudinally, by broader rays of soft bast. The absence of stone cells distinguishes it from, but otherwise is substantially the same as, *V. prunifolium* (263). inodorous; taste astringent and bitter.

Powder.—Light brown. Characteristic elements: Parenchyma of inner cortex, with calcium oxalate prisms; middle bark bearing reddish-brown coloring-matter, starch (5 to 12 μ in diam.); long thick-walled bast fibers numerous; few stone cells; crystals of calcium oxalate, in prisms, few aggregate (15 to 30 μ in diam.); crystal fibers with calcium oxalate in prisms.

Action and Uses.—Claimed to be **antispasmodic,** hence the name cramp bark. Dose: 30 gr. to 2 dr. (2 to 8 Gm.).

Official Preparation.

Fluidextractum Viburni Opuli,........Dose: 1 to 2 fl. dr. (4 to 8 Cc.).

263. VIBURNUM PRUNIFOLIUM.

BLACK HAW.

The dried bark of the root of **Vibur'num prunifo'lium** Linné or of **V. lentago** Linné.

Botanical Characteristics.—A tall shrub or small tree. *Leaves* oval, obtuse, or slightly pointed, finely serrate. *Cymes* compound, sessile. *Fruit* an oval, black, sweet drupe.

Habitat.—Middle and Southern United States, east of the Mississippi.

Description of Drug.—In thin pieces or quills, glossy purplish-brown, with scattered warts and minute black dots; when collected from old roots, grayish-brown; the thin corky layer easily removed from the green layer; inner surface yellowish to brownish, smooth; fracture

FIG. 120 —*Viburnum prunifolium*—Branch with flowers.

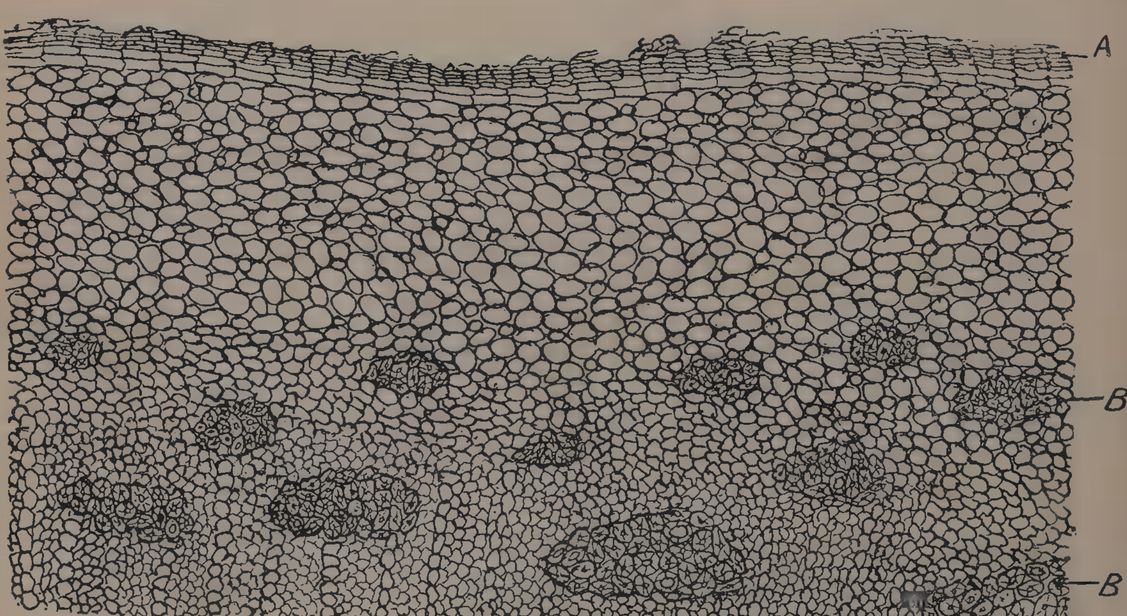

FIG. 121.—*Viburnum prunifolium*—Bark of root, cross-section. *A*. Cork. *B*. Group of stone cells in cortical parenchyma.

short; inodorous, astringent and bitter. Cross-sections display, instead of the bands of bast fibers, as in *V. opulus*, numerous groups of stone cells irregularly disposed.

Powder.—Dark brown. Characteristic elements: Parenchyma of inner cortex, with prisms and aggregate calcium oxalate (15 to 35 μ in diam.), middle parenchyma tangentially flattened with some starch (5 to 30 μ in diam.); stone cells large, numerous (30 to 100 μ in diam.); crystal fibers with aggregate crystals and prisms of calcium oxalate; large cork cells; bast fibers not abundant (20 to 30 μ thick).

CONSTITUENTS.—A brown resin, a bitter principle (viburnin), valerianic acid, tannic acid, oxalic, malic, and citric acids, sulphates, and chlorides.

ACTION AND USES.—Diuretic, and a **tonic and sedative to the uterine and ovarian nerve centers;** used in threatened abortion. Dose: 30 to 60 gr. (2 to 4 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Viburni Prunifolii, ...Dose: 30 to 60 ♏ (2 to 4 Cc.).

264. **TRIOSTEUM.**—FEVER ROOT. BASTARD IPECAC. The root of **Trios'teum perfolia'tum** Linné, common in most parts of the United States. (See Conspectus.) Cathartic and emetic in large doses. Dose: 15 to 30 gr. (1 to 2 Gm.).

RUBIACEÆ.—Madder Family.

Herbs, shrubs, or trees, with opposite, simple, and entire *leaves*, connected with interposed stipules, or in whorls without stipules. A very large family in tropical regions, represented by the coffee plant (Arabia and Africa) and by the cinchonas (South America).

Synopsis of Drugs from the Rubiaceæ.

A. *Root.*
  IPECACUANHA, 265.
B. *Rhizome.*
  Rubia, 266.
C. *Bark.*
  CINCHONA, 267.
  CINCHONA RUBRA, 267 a.
  Remijia, 268.
  Cephalanthus, 269.
D. *Herb.*
  Mitchella, 270.
  Galium, 271.
E. *Seed.*
  Caffea, 272.
F. *Extractive.*
  Catechu Pallidum (Gambir), 273.

265. IPECACUANHA.—IPECAC.

IPECAC. *Ger.* RUHRWURZEL.

The dried root, to which may be attached a portion of the stem not exceeding 7 cm. in length, of **Cephæ'lis Ipecacuan'ha** (Brotero) A. Richard (Fam. *Rubiaceæ*), known commercially as *Rio*, *Brazilian*, or *Para Ipecac*, or corresponding portion of **C. acuminata** Karsten, known commercially as *Carthagena Ipecac*. The value is dependent upon the percentage of alkaloidal constituents. Rio Ipecac yields from 1 to 2 per cent. of emetine and from 0.25 to 1 per cent. of cephæline; Carthagena

yields from 1.16 to 1.94 per cent. of emetine and from 0.59 to 1.3 per cent. of cephæline. **When assayed by the official process the root should yield not less than 2 per cent. of total alkaloids.**

BOTANICAL CHARACTERISTICS.—The root perennial, knotty, with transverse rings; *stems* suffruticose, ascending, somewhat pubescent toward the apex. *Leaves* opposite, oblong, roughish above, finely pubescent beneath. *Inflorescence* capitate, inclosed by a large one-leafed involucre; *flowers* bracteate; *corolla* white, funnel-form, the limb with reflexed segments; *stamens* 5, slightly exserted. *Fruit* a dark violet berry, crowned by the limb of the calyx, 2-celled, 2-seeded.

FIG. 122.—*Cephælis ipecacuanha*—Plant and dried root.

SOURCE AND VARIETIES.—Grows in the damp woods of the Brazilian valleys, notably in the provinces of Para, Rio Janeiro, Pernambuco, etc. This variety is known in commerce as Rio ipecac, while that from Colombia is called Carthagena ipecac. The former is usually preferred, but the latter is now more common. The plant *Psychotrin*

medica is sometimes termed and sold as Carthagena ipecac, but it is devoid of alkaloid. The Brazilian plant is quite hardy, appearing as a creeping vine or bush. The roots usually grow thicker as they penetrate the ground and then taper off again to a point or thin rootlet. Collectors usually leave a part of every other plant in the ground, so that in about three years another crop may be harvested. "Wiry root," consisting of about 75 per cent. of woody portion and 25 per cent. cortex, is, according to Dohme, richest in alkaloids. It has a rather rough, uneven appearance, and is popularly less esteemed than the so-called "fancy" root consisting of 75 per cent. cortex. This prejudice, according to Dohme, is difficult to overcome.

DESCRIPTION OF DRUG.—**Rio Ipecac.**—In pieces of irregular length, rarely exceeding 25 cm.; stem portion 2 to 3 mm. thick, light gray-brown, cylindrical and smoothish; root portion usually red-brown, occasionally blackish-brown, rarely gray-brown, 3 to 6 mm. thick, curved and sharply tortuous, nearly free from rootlets, occasionally branched, closely annulated with thickened, incomplete rings, and usually exhibiting transverse fissures with vertical sides, through the bark; fracture short, the very thick, easily separable bark whitish, usually resinous, the thin, tough wood yellowish-white, without vessels; odor very slight, peculiar, the dust sternutatory; taste bitter and nauseous, somewhat acrid.

FIG. 123.—Ipecac—Cross-section of Root. (25 diam.) A, Cork. B, Parenchyma of cortex. C, Xylem. (Photomicrograph.)

Carthagena ipecac is of a dull gray color, thicker, less frequently and sharply crooked, and lacks the constrictions characteristic of Rio ipecac, although it bears the annular thickenings, or merging annulæ. The thick bark, on cross-section, has rather a grayish color, the medullary rays are more prominent and more numerous.

STRUCTURE.—The thin outer layer of cork cells contains a brownish-red deposit, thought by some to be emetine in combination with ipecac-

uanhic acid. The thick inner cortical layer consists of starchy parenchyma, free from medullary rays, but containing a circle of stone cells filled with calcium oxalate crystals. Transverse sections show rather a small layer of cork cells, a thick cortical portion consisting of parenchyma, loaded with starch and rich in alkaloid. The woody portion, radiate, contains little or no alkaloid.

Powder.—Fawn color. Characteristic elements: Parenchyma containing raphides, with starch, simple and 2 to 4 compound (4 to 14 μ in diam.) (starch grains in Carthagena Ipecac, larger); tracheids with simple or oblique pores. (See Ipecac starch grains highly magnified, Fig. 366.)

CONSTITUENTS.—**Emetine** (1 to 2 per cent.), cephaëline, psychotrine, and a peculiar tannic acid called ipecacuanhic or cephaëlic acid, starch, resin, etc. The active principles exist only in the bark of the root, and probably in the thin, outer layer of cork cells. Recently considerable light has been thrown on emetine, $C_{15}H_{22}N_2O_5$, and cephaëline, $C_{14}H_{20}NO_2$, which were formerly supposed to be one body. According to Paul and Cownley ("Pharm. Jour.," 1896) cephaëline is the emetic principle and emetine the expectorant principle of the drug. This naming is unfortunate, and should be reversed. Emetine is amorphous; cephaëline crystalline.

Recent researches show that Rio ipecac contains 1.45 per cent. of emetine (melting-point 68° C.), and 0.52 per cent. of cephaëline, while the Carthagena variety contains 0.89 per cent. of emetine and 1.25 of cephaëline (melting-point 96° to 98°). The latter variety is said to be the better one, because it runs higher in total alkaloids. Any sample of either, however, is liable to run high or low in total alkaloids, so that there is little ground for distinction between the two ipecacs. The U. S. P. requires that the drug shall contain 2 per cent. of total alkaloid.

Preparation of Emetine.—A very simple process is to exhaust the drug with boiling chloroform made slightly alkaline with solution of ammonia. Upon distilling off the chloroform the emetine is left in a very pure condition, and, when dried at 100° C., gives a residue which, when weighed, gives one a rough estimate of the value of the drug. Cephaëline is extracted usually with emetine in most of the processes for assay. It is less soluble in ether than emetine.

Preparation of Ipecacuanhic Acid (Cephaëlic Acid).—Precipitate decoction with lead acetate, dissolve precipitate with acetic acid, and precipitate solution with lead subacetate; wash and dry. Resembles caffeotannic acid.

ACTION AND USES.—In large doses a **systemic emetic,** in minute doses stomachic, aiding digestion. Ipecac has been used, since its introduction into medicine, as a remedy in dysentery, when there is said to be a peculiar tolerance of the drug; but the fact is the stomach almost invariably rejects large doses. Recent experiments prove that ipecac, when deprived of its emetine, possesses its full

antidysenteric properties, without the drawbacks of depression, nausea, etc. Accordingly there appears in the market to meet this peculiar demand a preparation made from **de-emetinized bark.** Dose as expectorant, 1 gr. (0.06 Gm.); emetic, 10 to 15 gr. (0.6 to 1 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Ipecacuanhæ, . Dose:	3 to 8 ♏ (0.2 to 0.5 Cc.); 15 to 60 ♏ (1 to 4 Cc.).
Syrupus Ipecacuanhæ (7 per cent.), ...	Adult exp. 30 ♏ (2.0 Cc.), Emetic 6 fl. dr. (24.0 Cc.).
Vinum Ipecacuanhæ (10 per cent.), ...	5 to 10 ♏ (0.3 to 0.6 Cc.).
Tinctura Ipecacuanhæ et Opii (10 per cent.), ...	5 to 15 ♏ (0.3 to 1 Cc.).
Mistura Rhei et Sodæ (0.3 per cent. with Sodium Bicarbonate, Fl'ext. Rhubarb and Sp. Peppermint), ...	1 fl. dr. (4 Cc.).
Pulvis Ipecacuanhæ et Opii (10 per cent. of each), ...	5 to 15 gr. (0.3 to 1 Gm.).
Pilulæ Laxativæ Compositæ (.004 Gm., with Aloin, Strychnine, Extract of Belladonna leaves and Glycyrrhiza), ...	2 pills.

266. **RUBIA.**—MADDER. The rhizome of **Ru'bia tinc'torum** Linné. *Habitat:* Levant and Southern Europe, chiefly supplied from Holland, where it is cultivated. Usually comes into market in a coarse, red powder. Its most important constituent is **alizarin,** a red coloring-matter soluble in water and alcohol. Chiefly used as a dye.

267. CINCHONA.—CINCHONA.

PERUVIAN BARK. *Ger.* PERUVIANISCHE RINDE.

The dried bark of **Cincho'na Ledgeriana** Moens, **Cincho'na calisa'ya** Weddell, **Cincho'na officina'lis** Linné, and of hybrids of these with other species of Cinchona, yielding, when assayed, not less than 5 per cent. of anhydrous cinchona alkaloids. The bark should yield 4 per cent. of anhydrous alkaloids *soluble in ether,* when assayed by the U. S. P. process.

SOURCE, VARIETIES, HISTORY, ETC.—The genus Cinchona is composed of over three dozen species, but few furnish the commercial barks. It is well known that the original source of the drug is South America (10° N. lat. to 19° S. lat., from about 3000 to 12,000 feet above sea-level), the area of the growth of the various species being confined exclusively to the Andes, chiefly on the eastern face of the Cordilleras—occasionally on the western face, which is covered by forests. The best known varieties from South America were the dark brown Loxa bark and the pale yellow-gray Huanuco. The cinchonas seldom form an entire forest, but rather groups interspersed among tree-

ferns, gigantic climbers, bamboos, etc., sometimes growing separately in exposed situations, but under peculiar climatic conditions, such as a great humidity of atmosphere and a mean temperature of about 62°. Shade seems to favor the development of alkaloids. Dymock calls attention to the fact that "the north or shaded side of a tree has a richer bark than that on the south side," a fact which explains the success of the "mossing system."*

Cultivated trees in recent years have been the chief source of the commercial barks. To some extent the cultivation has been carried on in South America, but great success has attended the persevering efforts of the Dutch Government and the Government of British India. Extensive plantations of cinchona are now flourishing, to the extent of over five million trees of the more important species, on the Neilgherry Hills and in the valleys of the Himalaya in British Sikkin. The tree is also cultivated in Ceylon, Java, Jamaica (Blue Mountains), and other countries.

VARIETIES.—Dohme ("Druggists' Circular," p. 296, 1896) divides the barks as follows:

1. Those barks that are histologically true cinchona barks and at the same time contain cinchona alkaloid.

2. Those that are histologically not cinchona barks, but still contain cinchona alkaloids.

3. Those barks that simulate cinchona barks, but are not histologically cinchona, and do not contain cinchona alkaloids.

There are about twenty varieties of cinchona barks, and it is a very difficult matter to distinguish them, since they have been and are now changed so much by grafting and crossing. The varieties generally used and best known are: *C. succirubra* Pavon, *C. cali-*

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* There are four methods of collecting or harvesting the bark: (1) By taking it in longitudinal strips from the standing tree and leaving the bark to renew over the exposed wood; (2) by scraping and shaving off the bark; (3) by coppicing; and (4) by uprooting. The first is most in use. . . . The trees are barked preferably in the rainy season, when the bark "lifts," or is more easily removed from the wood. The coolie inserts the point of a knife in the tree as far as he can reach and draws it down, making an incision in the bark straight to the ground; he then makes another cut parallel to the first, about an inch and a half distant, and, loosening the bark with the back of the knife, the strip or ribbon is taken off. If the operation is performed carefully and the cambium cells are not broken, a new layer of bark will be formed in place of that which is taken away. The tree is then covered with moss, grass, or leaves, bound on by strings or fiber. All this is done to foster the growth of the new bark (renewed bark) from the cambium and to thicken the untouched layers of natural bark, which is now termed **mossed bark.**—*Pharmacographia Indica.*

Outline map of South America, showing the native distribution of cinchona bark and certain other prominent drugs of that country. See also Geographical Classification of Drugs, page 18.

saya Weddell, *C. ledgeriana* Moens, *C. lancifolia* Mutis, and *C. officinalis* Hooker.

These would, of course, all come under class 1 of the above classification. *C. cuprea*, or *Remijia purdieana*, is the representative of class 2, and *C. nova*, also known as *C. bicolor*, *Ladenbergia magnifolia*, or *Cascarilla magnifolia* (nothing to do with *Croton eluteria*), represents class 3. The success of the Dutch

FIG. 124.—*Cinchona officinalis*—Branch.

planters of Java has been so pronounced that the greater portion of cinchona bark comes from this place, the leading varieties being ledgeriana and succirubra bark. Verne states that cultivation of cinchonas in tropical localities should be confined to the *Ledgeriana* variety, that the *C. succirubra* should be restricted. Major D. Train, the superintendent government quinologist of the Bengal cinchona plantations, states ("Chem. and Drugg.," Aug. 24, 1901, 358) that

the bulk of the bark harvested on the Bengal plantations during the year 1899–1900, taken from sickly and stunted trees, amounted to 208,652 pounds, all quinine-yielding barks. In Java greater care in general is exercised in the cultivation and the trees are allowed to reach the age of twelve years before the bark is collected. Moreover, the cultivation is confined to the variety Ledgeriana. Over 500,000 pounds are collected annually from Java plantations.

DESCRIPTION.—In quills or curved pieces of variable size, usually 2 or

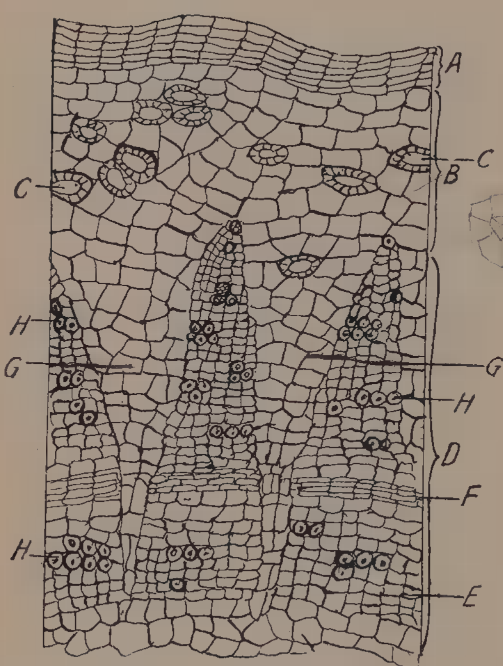

FIG. 125.—*Cinchona calisaya*—Cross-section of bark. *A.* Cork cells. *B.* Cortical parenchyma. *C.* Stone cells. *D.* Phloëm portion. *E.* Soft bast. *F.* Phellogen forming bork. *G.* Medullary rays. (The black line from *G* should be extended to the parenchyma cells between the phloëm portions.) *H.* Bast fibers.

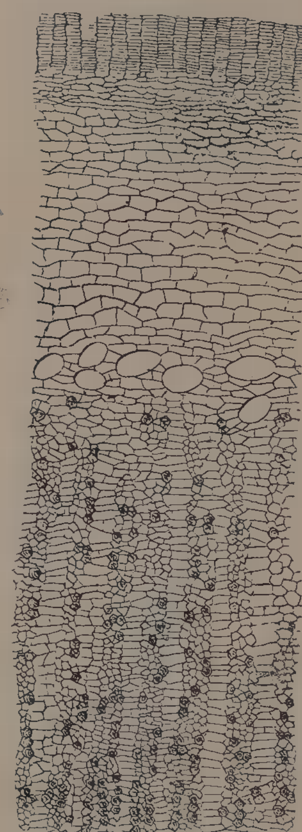

FIG. 126.—Cross-section of *Cinchona calisaya* bark (var. Micrantha).

3, sometimes 5 mm. thick; externally gray, rarely brownish-gray, with numerous intersecting transverse and longitudinal fissures, having nearly vertical sides; the outer bark may be wanting, the color externally being then cinnamon brown; the inner surface light cinnamon brown, finely striate; fracture of the outer bark short and granular, of the inner finely splintery; powder light brown or yellowish-brown; odor slight, aromatic; taste bitter and somewhat astringent.

MICROSCOPICAL.—The calisaya (variety Micrantha) transversely shows milk-vessels in the cortical parenchyma and absence of stone cells,

which are present in Lancifolia. The rays of the woody portion are more elongated and the medullary rays larger in size. Bast fibers comparatively small and less numerous, but are spindle-shaped, as they are in all true cinchona barks showing longitudinal section. In *C. rubra* the stone cells and milk-ducts are both wanting, while the bast fibers are more numerous and stouter. The bark is richer in coloring matter. In cuprea bark the cork cells are thicker and the cortical parenchyma cells smaller, stone cells present, milk-ducts absent, few bast fibers, but the woody portion contains indurated cells, which simulate them. The ligneous cells are very numerous and extend even down into the medulla. They are smaller than the bast fibers of true cinchona barks, but much more numerous.

These barks are thoroughly saturated with pigments, principally cinchona red, the phlobaphen of all cinchona barks. Before microscopical examination these pigments must be removed by a weak alcoholic solution of ammonia. This requires considerable practice (Dohme). Compared with other barks, the fibers of the liber of cinchona are shorter and more loosely arranged, being for the most part separated into simple fibers imbedded in the bast parenchyma, or united into very short bundles.

Grahe's test for the distinction of cinchona bark is as follows: On heating about 0.1 Gm. ($1\frac{1}{2}$ gr.) of the powdered bark in a dry test-tube a tarry distillate of a red color is obtained. (*Constituents, see below.*)

267 **a. CINCHONA RUBRA.**—The dried bark of *Cinchona Succirubra* Pavon or its hybrids. "In quills or incurved pieces, varying in length, and from 2 to 4 or 5 mm. ($\frac{1}{12}$ to $\frac{1}{6}$ or $\frac{1}{5}$ in.) thick; the outer surface covered with a grayish-brown cork, more or less rough from warts and longitudinal, warty ridges, and from few, mostly short and not frequently intersected transverse fissures, having their sides sloping; inner surface more or less **deep reddish-brown** and distinctly striate; fracture short, fibrous in the inner layer; outer layer, granular. **This bark should yield at least 5 per cent. of total alkaloids.**

Powder.—Yellowish-red to reddish-brown. Characteristic elements: Parenchyma of cortex with spherical starch granules, simple (4 to 12 μ in diam.); few cells with crystal sand, others with reddish-brown tannin; sclerenchyma with bast fibers short, thick, spindle-shaped (40 to 120 μ thick) (400 to 1000 μ long); thick-walled stone cells (40 to 60 μ by 100 to 200 μ); cork, considerable quantity; red cinchona, deep red with KOH.

CONSTITUENTS.—Upon **quinine,** $C_{20}H_{24}N_2O_2 3H_2O$, the bark almost exclusively depends for its value. This alkaloid is colorless, amorphous, or in acicular crystals; inodorous, very bitter; soluble in 1670 parts water, 6 parts alcohol, 26 parts ether. Aqueous solutions of the salts have a blue fluorescence, and when treated with chlorine

water and ammonia a beautiful green color is produced—"Thalleoquin test." The solutions deviate the plane of polarization to the left. The tartrate is soluble in water. A cold aqueous solution of the sulphate remains unaffected by potassium iodide T. S. (difference

FIG. 127.—*Cinchona succirubra*—Branch.

from quinidine) U. S. P. The other prominent principles, also **official** in the U. S. P., are as follows:

CINCHONIDINE, $C_{19}H_{22}N_2O$—isomeric with cinchonine, non-fluorescent; forms colorless, anhydrous crystals, soluble in 20 parts alcohol (80 per cent.), 1680 of water, and 188 of ether. The sulphate is more soluble in water than quinine, and the tartrate very insoluble. The Thalleoquin test (see above) gives a white precipitate. Represented in Cinchonidinæ Sulphas, U. S.

CINCHONINE, $C_{20}H_{24}N_2O$—white lustrous prisms, soluble in 3760 parts water, 116 parts alcohol, and 526 parts ether; has exactly the opposite action to cinchonidine and quinine upon polarized light.

QUINIDINE, $C_{20}H_{24}N_2O_2$—isomeric with quinine; crystallizes in prisms soluble in 2000 parts water, 0.8 part alcohol, about 30 parts ether; turns the plane of polarization to the right. A cold aqueous solution of the sulphate yields a white precipitate with potassium iodide T. S. (difference from sulphate of quinine). Represented in Quinidinæ Sulphas, U. S.

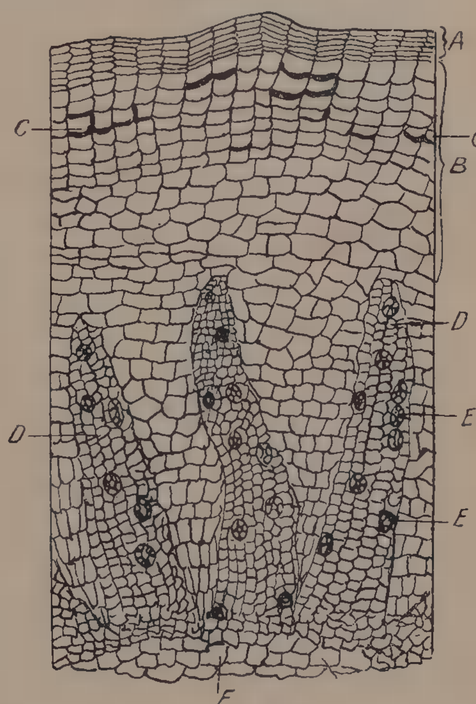

FIG. 128.—*Cinchona rubra*—Cross-section of bark. *A*. Cork cells. *B*. Cortical parenchyma. *C*. Coloring matter, deposits between and within the cells. *D*. Medullary ray. (Black line from *D* should not extend beyond the first two rows of cells of the figure.) *E*. Bast fibers.

Among the **unofficial alkaloids and principles** found in the bark are the following: Isomeric with quinine and quinidine is **quinicine**; with cinchonine and cinchonidine, are **cinchonicine, homocinchonine, homocinchonidine, homocinchonicine,** and **apoquinamine**; a brown amorphous alkaloid is obtainable from the mother-liquor known as **chinoidine** (quinoidine), a mixture of various not well-defined alkaloidal substances; kinic acid, $C_7H_{12}O_6$, and kinovic acid; kinovin; bitter cinchonic acid (derived from preceding); volatile oil, a minute quantity.

Separation of Total Alkaloids.—Moisten powdered cinchona with ammonia water and allow it to stand for an hour, then hot water is added. To the mixture, after cooling, milk of lime is added and the whole evaporated to dryness. This is placed in an extraction apparatus and exhausted with ether. Water acidulated with HCl is added to neutralize the alkaloids and the ether distilled off. The cooled liquid is filtered and decinormal solution of soda is added. Finally, sodium hydrate is added to complete the precipitation of the alkaloids. There are numerous other processes, but this seems a simple and satisfactory one to use for assay purposes.

YIELD OF ALKALOID.—The richest government bark brought to the market until recently has not exceeded 9½ per cent. of sulphate of quinine; 7 to 8 per cent. is a good average in government plantations.

Barks taken from the trees in the government gardens at Pioeng Goenoeg, Java, have recently been analyzed and found to equal respectively 12.66 and 16.04 per cent. of quinine sulphate.

ACTION AND USES.—The action of cinchona bark is due almost entirely to the alkaloids therein contained. Quinine is a powerful antiseptic, destructive, in weak solution, to infusórial and vegetable life. Internally it stimulates the muscular fibers of the stomach, acting as a bitter tonic, invigorating the vital functions and aiding digestion. In large doses the brain is affected, giving rise to symptoms such as fullness, frontal headache, deafness, ringing in the ears, and mental dullness. This effect is called "cinchonism," attributed to partial anæmia of the brain, contraction of blood-vessels, etc. Heart action is depressed. Reflex excitability of the spinal cord is lowered. In the blood, quinine arrests the migration of the white corpuscle and checks its amœboid movement; the oxygen-carrying function of the red corpuscle is impaired; infectious micro-organisms in the blood and tissues are probably rendered inactive or destroyed. The toxic symptoms produced by quinine and allied salts are spoken of collectively as cinchonism, which ordinarily is not allowed to go further than tinnitus aurium (Shoemaker).

Dose of cinchona: 15 to 60 gr. (1 to 4 Gm.), in powder, fluidextract, or its equivalent in the salts of the alkaloids.

OFFICIAL PREPARATIONS.

Fluidextractum Cinchonæ, ...	Dose: 10 to 60 ♏ (0.6 to 4 Cc.).
Tinctura Cinchonæ (20 per cent.),......	1 to 4 fl. dr. (4 to 8 Cc.).
Tinctura Cinchonæ Composita (10 per cent., with bitter orange-peel 8 per cent., and serpentaria 2 per cent.) (Cinchona Rubra), ...	1 to 4 fl. dr. (4 to 15 Cc.).

268. **REMIJIA.**—CUPREA BARK. The bark of **Remij'ia peduncula'ta** Triana and of **Remijia purdiea'na** Weddell, resembling cinchona in physical properties and constitution. A copper-red bark from the United States of Colombia, grown at an altitude of from 3000 to 6000 feet, usually in flat or curved pieces; odor slight; taste bitter. Quinine is contained in this bark to the amount of 0.5 to 2.5 per cent., but no chinchonidine is found; homoquinine—a compound of quinine and cupreine—is also a constituent. Remijia bark is largely imported by manufacturers; it was said that the importations of this bark at one time exceeded in amount the entire importations of all the cinchona barks, by reason of its cheapness for the manufacture of quinine. Cinchonamine, $C_{19}H_{24}N_2O$, is one of the principal products of *R. purdieana*, the bark from which does not respond to Grahe's test.

269. **CEPHALANTHUS OCCIDENTALIS** Linné.—BUTTON BUSH. POND DOGWOOD. *Habitat:* United States. (Bark.) Tonic, febrifuge, laxative, and diuretic. It has an indirect action on the lungs, and is much used in consumption, coughs, and colds generally. Dose: 30 to 60 gr. (2 to 4 Gm.).

270. **MITCHELLA.**—SQUAW VINE. PARTRIDGE BERRY. The herb of **Mitchell'a re'pens** Linné, a creeping evergreen growing in the woods of this

country east of the Mississippi. Stem branching, bearing roundish-ovate, entire, evergreen leaves, about 12 mm. ($\frac{1}{2}$ in.) long, sometimes marked with white lines; flowers pale purplish, the ovary ripening into a small, scarlet-red berry. Tonic, astringent, and diuretic, resembling pipsissewa in action and often substituted for it. It is frequently combined with black haw. Dose: 30 to 60 gr. (2 to 4 Gm.).

271. **GALIUM.**—Cleavers. Lady's Bedstraws. The herb of **Ga'lium apari'ne** Linné. *Habitat:* Northern Hemisphere. Stem weak, quadrangular, prominently winged, and covered with retrorse prickles; leaves linear-lanceolate, borne in whorls. Flowers small, white, axillary, the single ovary ripening into a two-seeded, bristly fruit. Aperient, diuretic, and alterative; also used in psoriasis and other skin diseases. Dose: 30 to 60 gr. (2 to 4 Gm.), in infusion.

G. ve'rum (Yellow Lady's Bedstraw) has a smooth stem, bearing yellow flowers. *G. triflo'rum* contains coumarin, and has a fragrant odor when dry.

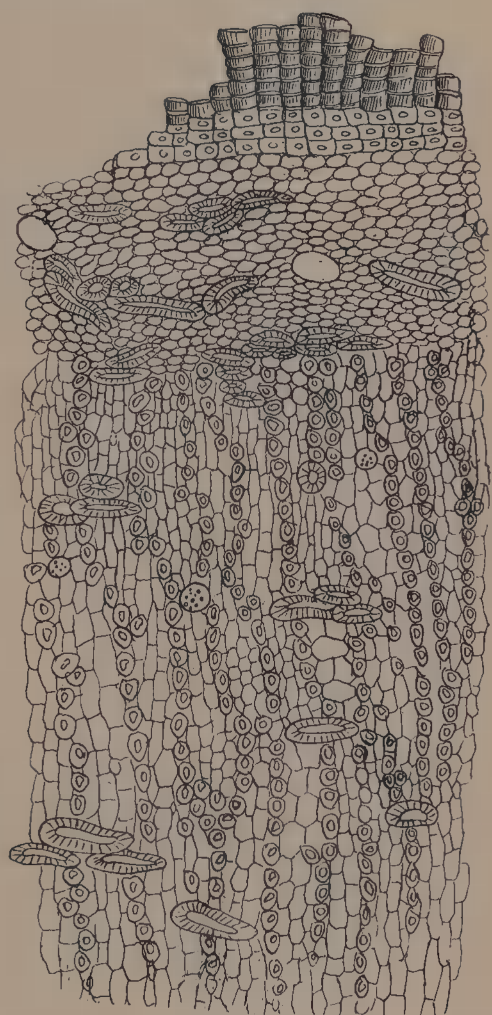

Fig. 129.—Cross-section of Cuprea bark.

272. **CAFFEA.** — Coffee. The seeds of **Cof'fea arab'ica** Linné. *Habitat:* Southern Arabia and Abyssinia; cultivated in South America, Java, and various tropical countries. The fruit is a roundish berry, about the size of a large cherry, becoming dark purple, and containing two seeds, which are inclosed within a membranous covering, and a purplish pulp. These seeds, when freed from the pericarp, form the coffee of the market. They are brownish-green or bluish-gray, plano-convex, the flat surface being elliptical, with a longitudinal groove curving deeply into the horny albumen; odor peculiar, faint, growing stronger by age; taste sweetish, somewhat astringent. Good berries are hard and sink readily in water. Soft, light, dark-colored berries should be rejected.

Constituents.—Its properties depend upon the alkaloid caffeine (2 to 8 per cent.), the constituent common to most of the stimulating beverages. It also contains sugar, tannic acid, caproic acid, fat, etc. When roasted, the sugar is converted into caramel, the caffeic acid partially into methylamine, and several volatile and empyreumatic substances (caffeone) are formed, giving to coffee its peculiar aroma. It loses from 15 to 18 per cent. of moisture in drying.

Preparation of Caffeine (Theine).—Precipitate infusion of tea or coffee with lead acetate; remove lead from filtrate with H_2S; concentrate second filtrate, neutralize with NH_4OH, and allow it to cool, when caffeine will crystallize out.

An aqueous solution of caffeine does not form a precipitate with Mayer's reagent. For estimation of caffeine in tea or coffee see "Proc. Amer. Pharm. Assoc.," 1897, p. 712.

ACTION AND USES.—Cerebrospinal stimulant, tonic; aids digestion and allays hunger and fatigue by lessening tissue waste.

273. **CATECHU PALLIDUM.**—TERRA JAPONICA. GAMBIR. (See also p. 194.) An extract obtained from a climbing plant of the East Indies, **Ourouparia Gambir** (Hunter) Baillon, by boiling the leaves, twigs, etc., in water. It is in about one-inch cubes, or in irregular pieces, reddish-brown or yellowish, breaking with a dull, earthy, pale yellowish fracture, showing under the microscope numerous crystals; inodorous; taste astringent and bitter, leaving finally a sweet taste in the mouth. It is mostly used in this country in tanning, dyeing, etc.; in its native country it is chewed with betel-nuts.

VALERIANEÆ.

Herbs with opposite, exstipulate *leaves*. *Flowers* in panicled or head-like cymes. Many of the species possess antispasmodic properties, due to the presence of a volatile oil, from which is developed valerianic acid

274. VALERIANA.—VALERIAN.

VALERIAN. *Ger.* BALDRIANWURZEL.

The rhizome and roots of **Valeria'na officina'lis** Linné.

BOTANICAL CHARACTERISTICS.—*Root* perennial, tuberous. *Leaves* pinnate or pinnately cut. *Corolla* roseate, funnel-form, 5-lobed; *stamens* 3. *Fruit* a feathery akene.

SOURCE.—Europe, especially in Holland, Belgium, England, and Germany, as well as Japan. The Japanese root is said to be richer in volatile oil than the Belgian. The fresh rhizomes and roots are preferred for distilling the oil, as there is a loss of nearly 50 per cent. of the oil in drying the rhizome and root for medicinal use.

DESCRIPTION OF DRUG.—Obconical, from 6 to 75 mm. ($\frac{1}{4}$ to 3 in.) in length, with stem-remnants above, and beset with numerous rootlets; those rhizomes grown in dry localities are smaller, nearly globular, with lighter colored, thinner, and less shriveled rootlets, and contain a greater proportion of volatile oil than those grown in moist ground; the latter are generally sliced longitudinally. Externally brown, internally pale brownish; **odor** strong, disagreeable, increasing with age; taste camphoraceous and bitter. A **cross-section** shows a rather thin bark, and a wood-circle, narrow, white, inclosing a large pith. Nucleus sheath mostly indistinct; branches have a similar structure but a thicker bark. The rootlets have a thick bark and a slender, woody column, distinctly radiate, and contain a small pith inclosed in a nucleus sheath.

Powder.—Light brown to dark brown. Characteristic elements: Parenchyma of cortex with cells thin or thick-walled, with starch, spherical (3 to 15 μ in diam.), simple or compound; sclerenchyma with stone cells, very thick-walled (20 to 30 μ in diam.); ducts with scalariform, spiral, annular, simple pores; wood fibers and wood parenchyma with simple pores; cork, small amount, brown.

FIG. 130.—*Valeriana officinalis*—Plant and rhizome.

CONSTITUENTS.—Besides the common vegetable principles, it contains a terpene, isovaleric acid, $C_5H_{10}O_2$ (distilling at 300° C.), and a **volatile oil** of complex constitution, consisting mainly of an alcohol, borneol; its ether, and its formic, acetic, and valerianic acid esters, which are gradually decomposed on exposure, liberating the acids. This oil (Oleum Valerianæ, U. S.) is of a pale greenish color, be-

coming yellow and viscid on exposure, and has the peculiar odor of the root.

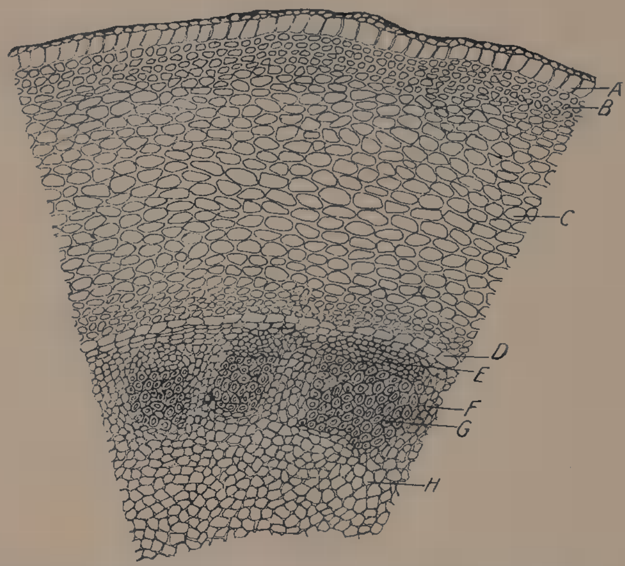

FIG. 131.—Valerian—Cross-section of rhizome. *A*. Cork cells. *B*. Collenchyma. *C*. Cortical parenchyma. *D*. Endodermis. *E*. Small irregular liber-cells. *F*. Medullary rays. *G*. Punctated vessels of wood-rays. *H*. Pith-cells.

FIG. 132.—Valerian—Cross-section of rootlet. (17 diam.) A, Epidermis. B, Parenchyma of cortex. C, Phloem. D, Xylem. (Photomicrograph.)

ACTION AND USES.—Gentle nerve stimulant and **antispasmodic, employed in hysterical disorders.** Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Valerianæ, ... Dose:	30 to 60 ♏ (2 to 4 Cc.).
Tinctura Valerianæ (20 per cent.),.....	1 to 2 fl. dr. (4 to 8 Cc.).
Tinctura Valerianæ Ammoniata (20 per cent.), ...	30 to 60 ♏ (2 to 4 Cc.).

COMPOSITÆ.—Composite Family.

Herbaceous or woody plants, rarely shrubs, with the *flowers* in close heads on a common receptacle, and surrounded by a common imbricated involucre. *Stamens* 5, their anthers united into a tube surrounding the pistil. *Flowers* of two sorts, strap-shaped or ligulate, and tubular, and hence the family is divided into three tribes: Tubulifloræ (flowers tubular in all the perfect flowers, and ligulate in the marginal or ray-flowers), Ligulifloræ (all the flowers of the head being strap-shaped, ligulate), and Labiatifloræ (with tubular flowers more or less labiate). *Fruit* an akene.

Synopsis of Drugs from the Compositæ.

A. *Roots.*
- **TARAXACUM,** 275.
- Cichorium, 276.
- **PYRETHRUM,** 277.
- Pyrethrum Germanicum, 277 a.
- Inula, 279.
- **LAPPA,** 280.
- Polymnia, 282.
- Laciniaria, 283.
- Helianthella, 284.
- Echinacea, 285.

B. *Rhizomes.*
- Arnicæ Radix, 286.
- Cnicus Arvensis, 288.

C. *Leaves.*
- Erechthites, 289.
- Trilisa, 290.
- Pterocaulon, 291.
- Guaco, 292.
- Ambrosia, 293.
- Strumarium, 294.
- Spinosum, 295.
- Eupatorium Purpureum, 297.

D. *Herbs.*
- **EUPATORIUM,** 296.
- **GRINDELIA,** 298.
- Tanacetum, 299.
- Absinthium, 300.
- Artemisia, 301.
  - A. Frigida (a).
  - A. Vulgaris (b).
  - A. Abrotanum (c).
- Erigeron, 302.
- Erigeron Canadense, 303.
- Gnaphalium, 304.
- Helenium, 305.
- Achillea, 306.
- Tussilago, 307.
- Carduus Benedictus, 308.
- Silphium, 309.
- Mutisia, 310.
- Elephantopus, 311.
- Rudbeckia, 312.
- Bidens, 313.
- Senecio, 314.
- Solidago, 315.
- Lactuca Sativa, 317.
- Lactuca Canadensis, 318.
- Parthenium, 319.
- Cotula, 320.

E. *Flowers.*
- **MATRICARIA,** 321.
- **ANTHEMIS,** 322.
- **SANTONICA,** 323.
- **ARNICA,** 287.
- **CALENDULA,** 324.
- Carthamus, 325.
- Pyrethri Flores, 278.

F. *Concrete Juice.*
- **LACTUCARIUM,** 316.

G. *Volatile Oil.*
- **OLEUM ERIGERONTIS,** 303 a.
- Oleum Anthemidis, 322 a.

H. *Seeds.*
- Helianthus, 326.

I. *Fruit.*
- Lappæ Fructus, 281.

275. TARAXACUM.—Taraxacum.

DANDELION. *Ger.* LÖWENZAHNWURZEL.

The dried root of **Tarax'acum officina'le** Webber, collected in autumn.

Botanical Characteristics.—*Root* perennial; *leaves* radical, runcinate, pinnatifid or lyrate; scape hollow. *Flower-head* solitary, many flowered, yellow. After blossoming, and while the fruit is forming, a pappus raises which soon exposes to the wind the naked fruit, which is blown about.

Source.—A plant of very extensive geographical distribution, native to Europe, but very abundant in the United States, where, in some parts, it is a troublesome weed.

Description of Drug.—The dry root is fleshy, long, and tapering, seldom branching; 5 to 25 mm. ($\frac{1}{5}$ to 1 in.) thick at the top, surmounted by

several heads. Externally brownish, soon darkening by exposure. In the fall, about November, the root acquires a deep orange color throughout. **Internally** white, abounding in a bitter, inodorous, milky juice. A **cross-section** displays a **thick, white bark** with numerous **concentric** circles of laticiferous vessels surrounding a **yellow woody center.** The central column is easily separated from the thick bark, when the former is found to have along its exterior at intervals minute knotty projections; a cross-section of the root at this point shows woody fibers branching from the ligneous cord, penetrating, and passing through, the bark. Inulin spherules are plainly

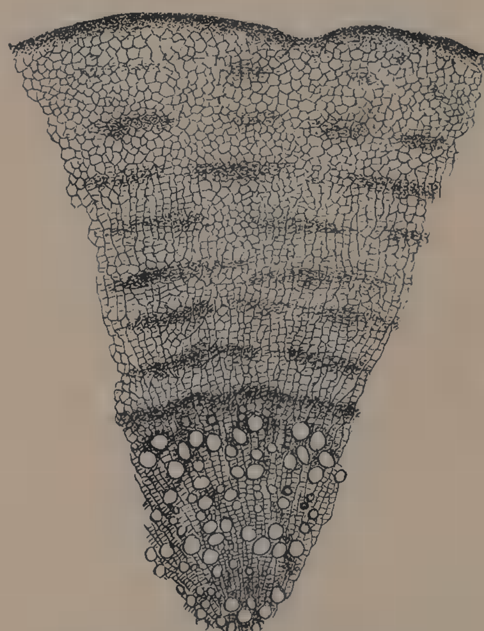

FIG. 133.—Cross-section of Taraxacum root.

discernible under the microscope if, before sectioning, the fresh root be macerated in alcohol. The root loses in drying fom 78 to 88 per cent. of moisture. The dried root is longitudinally and spirally wrinkled; when quite dry, has a brittle fracture, showing a dark brown exterior and a thick, white bark. The **powder** from the dried root is orange-brown; that root collected late in the fall, however, gives a bright orange powder; inodorous; bitter. Should be free from chicory (276).

ADULTERATIONS.—Besides the common chicory, the author has found admixture with hydrastis.

Powder.—Light brown. Characteristic elements: Parenchyma of cortex, thin-walled, medium-sized, with inulin in glassy masses or sphæro-crystals; ducts, reticulate; cork, small amount, brown; laticiferous vessels, yellowish

brown, with inulin and resinous emulsion latex, which is blue with chloral-hydrate-iodine.

CONSTITUENTS.—**Taraxacin** (a bitter principle), **taraxacerin,** $C_9H_{15}O$, resin, **inulin,** sugar, and mucilaginous substances. The percentage of sugar varies with different seasons and with condition of soil; it is said to diminish in the summer. Recent investigations have shown the existence of an alkaloid. But this has been found to be exceedingly minute—a mere trace.

Preparation of Taraxacin.—Treat decoction with animal charcoal, wash the latter with water, and dissolve out bitter principle with boiling alcohol; evaporate. It has not been proven that this is crystalline. Composition uncertain.

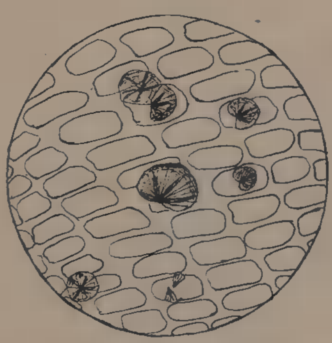

FIG. 134.—Inulin spherules in Taraxacum.

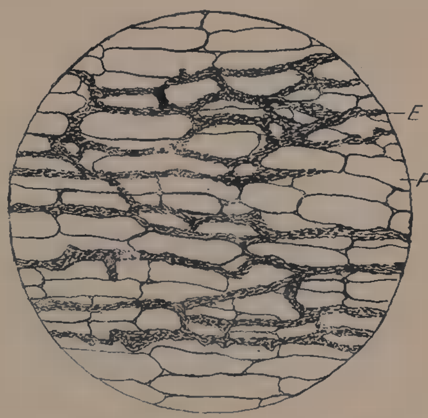

FIG. 135.—Laticiferous tissue in Taraxacum root. *E.* Laticiferous tissue. *P.* Parenchyma.

ACTION AND USES.—Deobstruent, tonic. The fluidextract and extract are used in **hepatic disorders.** Dose: 1 to 4 dr. (4 to 15 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Taraxaci, ...Dose: 1 to 4 fl. dr. (4 to 15 Cc.).
Extractum Taraxaci,................. 5 to 60 gr. (0.3 to 4 Gm.).

276. **CICHORIUM.**—CHICORY. The root of **Cichor'ium in'tybus** Linné. *Habitat:* Europe; naturalized in the United States. Nearly cylindrical, resembling dandelion, but lighter in color, more woody, with a thinner bark, and with the laticiferous vessels of the woody column and the bark arranged *radially;* very bitter. It contains inulin and a bitter principle. Bitter tonic in doses of 15 to 60 gr. (1 to 4 Gm.), in decoction. Its greatest demand is as an adulterant of coffee. It should be stated, however, that roasted chicory has become a favorite in many parts as a coffee substitute. The cultivation of the plant for this purpose and as a forage plant has grown to be a permanent agricultural industry in nearly every country of Europe and in many parts of the United States.

277. PYRETHRUM.—PYRETHRUM.

PELLITORY. ROMAN PELLITORY.

Ger. RÖMISCHE BERTRAMWURZEL.

The root of **Anacy'clus pyre'thrum** Linné.

BOTANICAL CHARACTERISTICS.—*Root* long, fusiform. *Stems* numerous, branched, pubescent. *Radical leaves* pinnatifid; *stem-leaves* sessile. *Florets* of the ray pistillate, white above and purplish beneath; of the disk, yellow, tubular, 5-toothed. *Akene* flat, winged; pappus short.

SOURCE.—Mediterranean Basin, coming solely from Algeria, thence to Mediterranean points.

DESCRIPTION OF DRUG.—**A hard, compact,** somewhat fusiform root, about the size of the little finger, with sometimes leaf-remnants at the top, and beset with few or no hair-like rootlets; externally brownish,

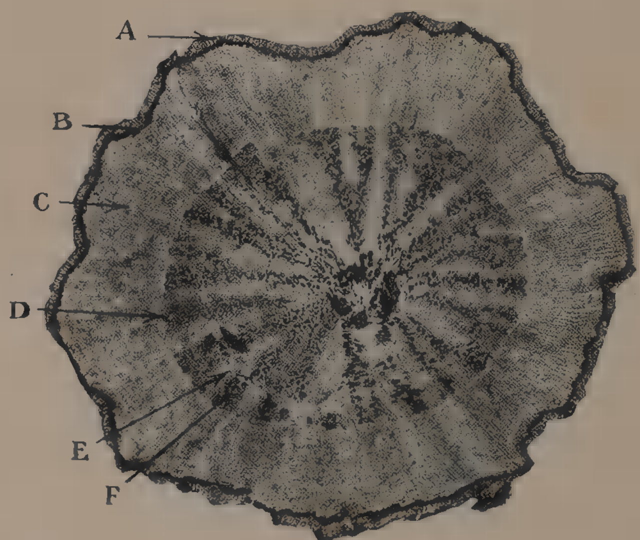

FIG. 136.—Pyrethrum—Cross-section of root. (11 diam.) A, Cork. B, Ring of stone-cells. C, Parenchyma of primary cortex. D Cambium. E, Medullary ray. F, Xylem. (Photomicrograph.)

deeply fissured longitudinally. It breaks with a short fracture, showing a rather thick bark adhering closely to the pale brown wood, from which it is separated by a narrow cambium line. This woody column is traversed by broad, distinct medullary rays, and contains, as does also the bark, large scattered resin ducts. Odor very slight; taste slight at first, but afterward **persistently acrid,** leaving a singular tingling sensation in the mouth and throat, and exciting a remarkable flow of saliva.

Pyrethrum Germanicum, from *Anacyclus officinarum* Hayne, is of a grayish color, about half as thick as above, tapering to filiform at

the lower end; has long been cultivated near Magdeburg and in Saxony. It resembles the above in foliage and flowers.

Powder.—Brown. Characteristic elements: Parenchyma of cortex, large with irregular masses of inulin and resin; sclerenchyma with stone cells, usually elongated, sometimes bast like; ducts, reticulate (50 to 75 μ in diam.), spiral; resin cells in parenchyma and fragments of anastomosing ducts; resin ducts with oil and resin in yellow lumps; numerous stone cells (30 to 50 μ in diam.), in cork.

CONSTITUENTS.—A very acrid resinous substance, two acrid oils—pyrethrin, extracted by ether (crystalline, bitter, burning taste), and pellitorine. Most of the parenchymatous cells are loaded with inulin, which forms about 35 per cent. of the root.

ACTION AND USES.—Used almost exclusively as a **sialagogue** in headache, neuralgic and rheumatic affections of the face, toothache, etc., or as a local stimulant in palsy of the tongue or throat, or relaxation of the uvula. Dose when chewed: 30 to 60 gr. (2 to 4 Gm.).

OFFICIAL PREPARATION.

Tinctura Pyrethri (20 per cent.), ... Used externally.

278. **PYRETHRI FLORES.**—INSECT FLOWERS. The flowers of (1) **Pyre'thrum carne'um** and **Pyrethrum rose'um** Weber, yielding, when powdered, Persian or Caucasian Insect Powder, and (2) **Pyrethrum cinerariæfo'lium** Visiani, yielding Dalmatian Insect Powder, which is more powerful than the Persian powder; this latter is now produced of very superior quality in California by cultivation. The plants resemble matricaria and bear flower-heads about 38 mm. (1½ in.) in diameter, surrounded by an imbricate involucre, (1) having brownish scales with a white scarious (membranous) edge, whitish ray-florets, and yellow disk-florets, and (2) having greenish involucral scales with scarious edge, rose-colored ray-florets, and yellow disk-florets. The flowers seldom come in market, but are in the form of a yellowish-brown or yellowish-green powder, which is used either as a powder or in tincture as an insecticide. It is not actively poisonous to human beings. Its strength or purity, and the variety from which obtained, may be ascertained by microscopical examination. A deficiency of pollen and presence of sclerenchymatous tissue would show a scarcity of flowers and the presence of stems in the powder, and consequent inferiority in strength.

279. **INULA.**—ELECAMPANE. The root of **In'ula Hele'nium.** Off. in U. S. P. 1890. Found in the market in slices cut in various directions. Externally grayish-brown, wrinkled, with overlapping bark. Internally gray. When dry, breaks with a horny fracture. Odor aromatic, suggestive of orris and camphor; taste slightly bitter, warm, aromatic. Gentle stimulant and tonic, supposed also to have diaphoretic, diuretic, expectorant, and emmenagogue properties. Chiefly used in this country for dyspepsia and pulmonary troubles. Dose: ½ to 2 dr. (2 to 8 Gm.), in powder or decoction.

280. LAPPA.—LAPPA.

BURDOCK. *Ger.* KLETTENWURZEL.

The dried root of **Arc'tium lappa** Linné, and possibly of other species of Arctium, collected from plants of the first year's growth.

BOTANICAL CHARACTERISTICS.—*Root* biennial, fusiform; *stem* 1 to 3 feet high. *Leaves* strong-smelling, ovate, with cordate and crenate base, or lanceolate,

with cuneate base. *Involucre* composed of imbricated coriaceous scales, the stiff, needle-like points of which are hooked. Heads solitary or clustered; *flowers* white or light purple, all tubular. *Akenes* oblong, flattened.

HABITAT.—Europe and Asia; naturalized in the United States.

DESCRIPTION OF DRUG.—A fusiform, fleshy root several inches in length and about 25 mm. (1 in.) thick, sometimes sliced longitudinally; grayish-brown, longitudinally wrinkled from drying, and having withered scales near the top; **internally** lighter colored, spongy, **a cross-section** showing a thick bark (in young roots, thin in old),

FIG. 137.—Lappa—Cross-section of root. (10 diam.) A, Cork. B, Resin cell. C. Xylem. D, Cambium. (Photomicrograph.)

the inner layer of which, and the meditullium, is traversed by broad medullary rays. Fracture horny. It has a slight unpleasant odor, and a sweetish, somewhat bitter taste.

Powder.—Brownish-gray. Characteristic elements: Parenchyma of cortex, thin-walled, elongated with glassy masses and sphæro-crystals of inulin; ducts large and small, with reticulate, simple pores; wood fibers and resin ducts, few.

CONSTITUENTS.—Mucilage, sugar, fat, a little tannin, a bitter glucoside (?), and inulin.

ACTION AND USES.—Diuretic, diaphoretic, and alterative. Dose: ½ to 2 dr. (2 to 8 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Lappæ, ... Dose: ½ to 2 fl. dr. (2 to 8 Cc.).

281. **LAPPÆ FRUCTUS.**—BURDOCK FRUIT. A somewhat angular fruit, about 6 mm. (¼ in.) long, rough and wrinkled, and covered with short, stiff hairs, which are easily rubbed off. Very bitter. A tincture is used in psoriasis and other skin diseases.

282. **POLYMNIA UVEDALIA** Linné.—BEARSFOOT. An indigenous plant, the root of which, in ointment form, has had virtues ascribed to it as a discutient and anodyne, particularly in the treatment of malarial splenic enlargements.

283. **LACINIARIA SPICATA** Willdenow.—BUTTON SNAKEROOT. *Habitat:* United States. (Root.) Diuretic; also used as a gargle and injection. Dose: ½ to 2 fl. dr. (2 to 8 Cc.).

284. **HELIANTHELLA TENUIFOLIA** Torrey and Gray.—The root of this plant has the properties of an aromatic expectorant and antispasmodic, used as an addition to cough mixtures.

285. **ECHINACEA.**—The root of **Echina'cea angustifo'lia** De Candolle. *Habitat:* Western United States. This plant has grown into considerable importance, especially among the eclectic practitioners, in the treatment of phagedenic ulcerations, boils, various forms of septicæmia, etc. The

FIG. 138.—*Echinacea angustifolia*—Root. A, Cross-section of root. (Photograph.)

common name of the plant is "nigger-head." The flower-head has from twelve to fifteen rays, 2 inches long, rose-colored or red, drooping; receptacle conical, with finely tipped chaff, longer than the disk-florets; disks purplish. The root has a brownish-black color, the epidermis shrunken causing longitudinally twisted wrinkles. Over 200,000 pounds were consumed in 1903.

In cross-section are seen wood-wedges and medullary rays, colored dark gray or blackish; fracture short and rough; taste peculiar and somewhat acrid and biting, reminding one of pyrethrum; odor heavy, mousey, accompanied by a peculiar pungency. The root contains a very small percentage of alkaloid and a crystalline principle soluble in carbon disulphide (see "Drug. Circ.," 1898, p. 124). Active principle contained, apparently, in an oleoresin. Allied species; *Echinacea purpurea.*

286. **ARNICÆ RADIX.**—ARNICA ROOT. A horizontal, contorted rhizome about 50 to 75 mm. (2 to 3 in.) long, and 3 to 4 mm. ($\frac{1}{8}$ to $\frac{1}{6}$ in.) thick;

externally dark brown, rough from scars, longitudinally wrinkled, and beset with numerous thin, fragile rootlets. Fracture short, showing a rather thick bark containing a circle of resin cells near the cambium line, a circle of short, yellowish wood-bundles, and a very large, whitish pith. Odor slightly aromatic; taste pungent and bitter. Adulterated with other roots of the Compositæ, also with *Geum urbanum* roots and *Frageria vesica* Off. in U. S. P. 1890. Stimulant and tonic. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

PREPARATIONS, Official 1890:

Tinctura Arnicæ Radicis (10 per cent.), . Dose: 20 to 30 ♏ (1.3 to 2 Cc.).
Fluidextractum Arnicæ Radicis, ... 5 to 30 ♏ (0.3 to 2 Cc.).
Extractum Arnicæ Radicis, ... 2 to 5 gr. (0.13 to 0.3 Gm.).
Emplastrum Arnicæ (33 per cent. of extract).

287. ARNICA.—ARNICA FLOWERS.

The dried flower heads of **Ar'nica montana** Linné.

DESCRIPTION OF DRUG.—About 25 mm. (1 in.) in length and 15 to 20 mm. ($\frac{3}{5}$ to $\frac{4}{5}$ in.) in diameter, surrounded by lanceolate, involucral scales; the receptacle is flat, and bears about 15 to 20 bright yellow, ligulate ray-florets, 3-toothed, striate, about 25 mm. (1 in.) long, and numerous shorter, tubular disk-florets; **pappus long and hairy,** giving the heads a characteristic appearance; **odor** peculiar and agreeable; taste persistently acrid and bitter. The powder is sternutatory. Adulterated with many flowers of the Compositæ, such as calendula, anthemis, inula, senecio, etc.

Powder.—Yellowish-brown. Characteristic elements: Trichomes, glandular, 2–5–10-celled, non-secretion, 1-6-celled; pollen, spherical (25 to 35 μ in diam.); ducts, spiral and porous; pappus multicellular axis with unicellular branches.

CONSTITUENTS.—Same as the root.

ACTION AND USES.—Same as the root. Dose: 15 to 30 gr. (1 to 2 Gm.). The tincture is used externally as a **vulnerary.**

OFFICIAL PREPARATION.

Tinctura Arnicæ (20 per cent.), ...Dose: 10 to 30 ♏ (0.6 to 2 Cc.).

288. **CNICUS ARVENSIS** Hoffmann.—CANADA THISTLE. An indigenous plant, the rhizome of which is popularly used for its astringent properties.

289. **ERECHTHITES HIERACIFOLIA** Rafinesque.—FIREWEED. *Habitat:* United States. (Leaves.) The name (fireweed) comes from the fact that the plant springs up spontaneously in burned districts. Tonic and astringent in dysentery, etc. Dose: 30 to 60 gr. (2 to 4 Gm.). The volatile oil of this plant has been used to adulterate the oil of erigeron.

290. **TRILISA ODORATISSIMA** Cassini.—DEER TONGUE. VANILLA LEAF. This plant contains **coumarin,** and the **leaves** are used in the Southern States to flavor tobacco. Aromatic, stimulant, and tonic; used as a corrective. Dose: 30 to 60 gr. (2 to 4 Gm.).

291. **PTEROCAULON PYCNOSTACHYON** Elliott.—BLACK ROOT. Leaves used by the Indians as an alterative. Dose: 15 to 30 gr. (1 to 2 Gm.).

292. **GUACO.**—By this name are known the leaves and roots of various herbs belonging to the genus **Mikania,** growing in Central and South America, where they are used as a febrifuge, anthelmintic, alterative, and alexipharmic. They at one time gained considerable attention in Europe in the treatment of epidemic cholera and chronic diarrhea. Dose: 15 to 30 gr. (1 to 2 Gm.).

293. **AMBROSIA ARTEMISIÆFOLIA** Linné.—RAGWEED. The leaves of this common weed are used in domestic practice as an astringent, styptic, and hemostatic.

293 a. **AMBROSIA.**—RAGWEED. The staminate flowers of **Ambrosia artemisiæfolia** Linné, North America. Staminate flowers very small, yellowish; surrounded by the cup-like, green involucre. *Preparation:* Fluidextract. *Properties:* Tonic and astringent. *Uses:* In treatment of inflammation from wounds and injuries; in hemorrhoidal tumors and ulcers; internally for hay-fever. Also in the treatment of dysmenorrhea.

294. **STRUMARIUM.**—CLOTBUR. COCKLEBUR. The leaves of **Xan'thium struma'rium** Linné. Hemostatic and styptic.

295. **SPINOSUM.**—SPINY CLOTBUR. The herb of **Xan'thium spino'sum** Linné. Diaphoretic, sialogogue, and diuretic. It is asserted that it has been used with success in warding off hydrophobia. Dose of fluidextract: 15 to 30 ♏ (1 to 2 Cc.).

296. EUPATORIUM.—EUPATORIUM.

BONESET. THOROUGHWORT. *Ger.* WASSERDOSTEN.

The dry leaves and flowering tops of **Eupato'rium perfolia'tum** Linné.

BOTANICAL CHARACTERISTICS.—*Stem* erect, 2 to 4 feet high, hairy; *leaves* lanceolate, united at the base around the stem (connate-perfoliate), tapering to a slender point, coarsely serrate, very wrinkled, downy beneath. *Heads* corymbed, 20- to 40-flowered, the florets all tubular, perfect, white. Pappus a single row of slender capillary bristles. *Akene* 5-angled (Fig. 139).

SOURCE.—Eupatorium grows in damp, swampy places, meadows, and banks over a large area of country from Nova Scotia to Florida. Besides the official *perfoliatum*, we have the *purpureum* (297), the *teucrifolium* (wild horehound), these latter two having been dropped from the Pharmacopœia in 1840. An allied species, *fœniculaceum* (dog fennel), growing from Virginia to Florida, yields a juice which has the reputation of relieving the pain of insect bites.

DESCRIPTION OF DRUG.—As it appears in the market, the drug consists of broken, wrinkled fragments of the dark green leaves and corymbs of the numerous white florets. The leaves have a rough upper surface, and downy, resin-dotted lower surface. Odor faintly aromatic; taste strongly bitter and slightly astringent.

Powder.—Yellowish-green. Characteristic elements: Sclerenchyma with bast fibers, thin-walled, very slightly or not at all lignified; ducts, spiral, annular, with bordered pits; trichomes, glandular and non-glandular present, 2- to 12-celled, of different shapes; stomata present; pollen, ellipsoidal (10 to 20 μ diam.); pappus, multicellular axis, unicellular branches.

CONSTITUENTS.—A peculiar, bitter, crystallizable glucoside (**eupatorin**), soluble in boiling water, alcohol, ether, and chloroform; resin, gum, tannin, and an undetermined wax-like, crystalline matter.

ACTION AND USES.—Stimulant and tonic, in large doses emetic and cathartic, and as a diaphoretic often used in warding off a cold and in

FIG. 139.—*Eupatorium perfoliatum*—Portion of plant and flower (enlarged).

fevers. Dose: 30 to 60 gr. (2 to 4 Gm.), in infusion, powder, or fluidextract.

OFFICIAL PREPARATION.

Fluidextractum Eupatorii, ...Dose: 30 to 60 ♍ (2 to 4 Cc.).

297. **EUPATORIUM PURPUREUM** Linné.—QUEEN OF THE MEADOW. GRAVEL ROOT. The leaves and root of this indigenous plant are an excellent diuretic. Also tonic, stimulant, and somewhat astringent. Dose: 30 to 60 gr. (2 to 4 Gm.).

298. GRINDELIA.—GRINDELIA.

GRINDELIA. *Ger.* GRINDELIENKRAUT.

The dried leaves and flowering tops of **Grinde'lia robus'ta** Nuttall, and of **Grinde'lia squar'rosa** Dunal.

BOTANICAL CHARACTERISTICS.—Woody herbs; *leaves* clasping, resinous, somewhat cuneate. *Involucre* hemispherical or globular, coated with resin; rays fertile, yellow; disk-florets yellow, tubular, and perfect. *Akenes* compressed, the outermost somewhat triangular; pappus awned. *Grindelia robusta* is found in rather elevated regions, while *G. squarrosa* is found in the plains. The former is more woody than the latter.

SOURCE.—This genus inhabits the western part of both North and South America. A resinous exudation is common to the various species of the genus, being most abundant in the flower-heads, and it is possible that medicinal properties are common to the genus. Besides the official species, there are found the *hirsutula* and the *glutimosa*, similar species growing in the western part of the United States, often cultivated and mixed with the official.

DESCRIPTION OF DRUG.—Rough, grayish-green fragments of the leaves, mixed with brownish-yellow stem fragments, and with flower-heads about 15 mm. ($\frac{3}{5}$ in.) in diameter, usually destitute of florets, leaving the **bare receptacle surrounded by the stiff, varnished, resinous bracts** of the involucre; odor balsamic; taste aromatic and bitter.

Distinction of the Two Species.—It may be said that the two species, *squarrosa* and *robusta*, resemble each other very much. *Robusta* is said to have a more leafy involucre and the leaves to be more coarsely serrate. The *squarrosa* in general is said to be less leafy and bushy, but on close examination of numerous specimens it is a question whether the distinction will hold.

Powder.—Pale brownish-green. Characteristic elements: Parenchyma of leaf with aggregate and prismatic crystals of calcium oxalate; sclerenchyma fibers, thin-walled; ducts spiral, annular, or with bordered pits, strongly lignified; trichomes, glandular and non-glandular, sessile, many-celled; pollen, spherical, about 25 μ in diam., oil and resin in numerous globules and masses; stomata, on both surfaces.

CONSTITUENTS.—The medicinal properties of grindelia seem to reside in **the resinous exudation.** An alkaloid principle has been claimed by some investigators and termed grindeline.

ACTION AND USES.—**Antispasmodic and sedative, in asthma.** Dose: 15 to 60 gr. (1 to 4 Gm.). The fluidextract is said to be an efficient application in rhus poisoning.

OFFICIAL PREPARATION.

Fluidextractum Grindeliæ,.............Dose: 15 to 60 ♏ (1 to 4 Cc.).

299. **TANACETUM.**—Tansy. The leaves and tops of **Tanace'tum vulga're** Linné. Off. in U. S. P. 1890. Leaves pinnate, the lobes sharply serrate, in wrinkled, broken pieces mixed with the reddish stems; midrib heavy and prominent on under side; odor strong, fragrant, diminished by drying; taste bitter, somewhat mint-like. *Constituents:* **Tanacetin,** $C_{11}H_{16}O_4$ (a bitter principle), malic acid, volatile oil (0.25 per cent.), tannin, resin, etc. Stimulant, tonic, emmenagogue, and anthelmintic. The dose of the volatile oil is from 1 to 5 ♏; used also as a domestic abortifacient and as a remedy for amenorrhea. Its use should be prohibited except upon physician's order, as it is a dangerous drug. Dose: 15 to 60 gr. (1 to 4 Gm.), in infusion.

300. **ABSINTHIUM.**—Wormwood. The leaves and tops of **Artemis'ia absin'thium** Linné. Off. U. S. P. 1890. Consists of the grayish, softly, hairy, longitudinally ribbed or furrowed stems with the petiolate, pinnatifid, pubescent leaves mostly broken beyond recognition; flower-heads in racemes, hemispherical, about 3 mm. (⅛ in.) broad; receptacle small, hairy, convex, with all yellow, tubular florets; akenes obovoid, without pappus; odor strongly aromatic; taste intensely bitter and nauseous. *Constituents:* Tannin, resin, malates, **absinthin,** $C_{15}H_{20}O_4$ (a bitter glucoside), **absinthic acid** (probably succinic acid), and a dark green volatile oil, about 1 per cent. (mainly absinthol), which has the odor of the drug, and when mixed with alcohol and oil of anise constitutes the absinthe of the French. Stomachic, tonic, anthelmintic and febrifuge. Dose: 15 to 60 gr. (1 to 4 Gm.).

Isolation of Absinthin.—Obtained by precipitating infusion, previously deprived of color, with tannin. The alcoholic extract of this precipitate is mixed with lead oxide and again extracted with alcohol. Absinthia deposits on evaporation of this tincture.

301. **ARTEMISIA.**—Nearly all the varieties of **Artemis'ia** seem to have similar properties—anthelmintic. Besides absinthium and santonica, some common indigenous plants of this genus are more or less used in medicine:

Artemisia abrotanum.—Southernwood. Old Man.

Artemisia vulgaris.—Mugwort. Also alterative and emmenagogue; and externally as a vulnerary.

Artemisia frigida.—Mountain Sage. Antiperiodic; first introduced as a substitute for quinine.

Artemisia tridentata.—Sage Brush—of the Rocky Mountains. **A. trifolia,** the dwarf variety of the above, and **A. dracunculus** Terragon, are well known, but only used locally in making domestic remedies of aromatic, bitter, and tonic character.

302. **ERIGERON.**—Fleabane. Daisy Fleabane. The herb of **Erig'eron an'nuus** Persoon, **E. philadelphicus** Linné, and **E. strigosus** Muhlenberg. *Habitat:* North America and Europe. All resemble one another and are indiscriminately employed in medicine. They have erect stems, much branched at the top, bearing terminal corymbs of wheel-shaped flowers having delicate, thread-like, white or purple ray-florets and yellow disk-florets; all parts of the plant are pubescent. Taste bitterish; odor feebly aromatic, due to a small quantity of volatile oil. Diuretic and stomachic, sometimes used in the treatment of gravel and dropsy. Dose: 30 to 60 gr. (2 to 4 Gm.), in infusion.

303. **ERIGERON CANADENSE** Linné.—Canada Fleabane. *Habitat:* North America. (Herb.) This differs from the other species principally in having a bristly stem and flowers with very inconspicuous ray-florets and straw-colored disk-florets. Odor aromatic; taste bitterish, somewhat acrid. It contains a bitter principle, and a volatile oil which is official in the U. S. P. Properties and dose about the same as preceding.

303 a. **OLEUM ERIGERONTIS,** U. S.—(Canada Fleabane.) A limpid, straw-colored liquid becoming thick and dark on exposure;

odor aromatic, persistent; taste characteristic. Adulterated with the oil of fireweed, *Erechthites hieracifolia* (289). Stimulant and diuretic, resembling oil of turpentine in action, especially as a hemostatic, but is less irritating and stimulating. Dose: 10 to 30 ♏ (0.6 to 2 Cc.).

304. **GNAPHALIUM.**—LIFE EVERLASTING. The herb of **Gnapha'lium polyceph'alum** Michaux. *Habitat:* North America. Leaves lanceolate, entire, woolly, sessile on the erect stem, which is branched, and bears dense terminal clusters of small obovate flower-heads surrounded by dry, whitish involucres; florets yellow, tubular; odor pleasant, taste aromatic, bitterish. It probably possesses little medicinal value, but is a popular domestic remedy, used as a tea in diarrhea, hemorrhages, etc., and externally in a fomentation as a vulnerary. Dose: 30 to 60 gr. (2 to 4 Gm.).

305. **HELENIUM.**—SNEEZEWORT. The herb of **Helen'ium autumna'le** Linné. *Habitat:* North America. A square-stemmed herb, the leaves and flowers of which, when powdered and snuffed up the nose, produce violent sneezing, hence the name sneezewort. It has been used as an errhine.

306. **ACHILLEA.**—YARROW. MILFOIL. The herb of **Achille'a millefo'lium** Linné, common in Europe and North America. Stem hairy, branched at top bearing the large corymbs of white flower-heads, each composed of five pistillate ray-florets, and greenish-white, perfect disk-florets; leaves lanceolate, thrice pinnatifid, the divisions linear. In market, however, the leaves are broken or crumpled, and the flower-heads destitute of florets; odor chamomile-like; taste aromatic, bitterish, and astringent. Used as a vulnerary and occasionally as an internal remedy for hemorrhages and mucous discharges, as in consumption. Dose: 30 to 60 gr. (2 to 4 Gm.), in infusion.

307. **TUSSILAGO.**—COLTSFOOT. The herb of **Tussila'go farfar'a** Linné. *Habitat:* Europe, and Middle and Northern United States, along the banks of streams. Demulcent, popularly used in the treatment of coughs (hence the name, from *tussis*, cough). Its expectorant properties are not pronounced, however. Dose: 30 to 60 gr. (2 to 4 Gm.), in decoction.

308. **CARDUUS BENEDICTUS.**—BLESSED THISTLE. The herb of **Cni'cus benedic'tus** Gaertner. *Habitat:* Levant and Europe. The drug consists of the woolly stems, with the soft, spiny leaves and a few of the large, ovate, yellow flower-heads; it has a slight, unpleasant odor and a very bitter taste. In cold infusion it is a bitter tonic, in hot infusion in large quantities diaphoretic and emetic. *Cnicus marianus* Gaertner has been used for the same purposes, and in Europe as a depurative.

309. **SILPHIUM LACINIATUM** Linné.—ROSIN WEED. *Habitat:* United States. (Herb or root.) It has given good results in intermittent fevers, and in dry, obstinate coughs, its action being somewhat like grindelia.

310. **MUTISIA VICIÆFOLIA.**—CHINCHIROCOMA. This herb is said to be a valuable antispasmodic and cardiac tonic.

311. **ELEPHANTOPUS TOMENTOSUS** Linné.—ELEPHANT'S FOOT. *Habitat:* United States. (Herb.) Diaphoretic and expectorant; in large doses emetic. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

312. **RUDBECKIA LACINIATA** Linné.—THIMBLE WEED. CONE FLOWER. This indigenous herb is used in catarrhal affections of the urinary tract. Diuretic and tonic. Dose: 15 to 60 gr. (1 to 4 Gm.).

313. **BIDENS BIPINNATA** Torrey and Gray.—SPANISH NEEDLES. An indigenous herb, popularly used as an emmenagogue. Dose: 15 to 60 gr. (1 to 4 Gm.).

314. **SENECIO AUREUS** Linné.—LIFE-ROOT. RAGWORT. (Herb.) Used by the Indians as a vulnerary. Emmenagogue. Dose: 30 to 60 gr. (2 to 4 Gm.), in infusion, decoction, or fluidextract.

315. **SOLIDAGO.**—Golden Rod. The herb of **Solida'go odo'ra** Aiton. (See Conspectus.) Aromatic, stimulant, carminative, and diaphoretic, in infusion. Used also to disguise the taste of other medicines.

316. LACTUCARIUM—Lactucarium.

LETTUCE-OPIUM. *Ger.* GIFTLATTISCHAFT.

The concrete milk-juice of **Lactu'ca viro'sa** Linné.

Botanical Characteristics.—A biennial, rank-smelling *herb*, abounding in a milky, acrid juice. *Root* napiform; *stem* 2 to 4 feet high, erect, slender, glaucous, slightly prickly below, covered here and there with blood-red spots. *Leaves* with midrib prickly, otherwise smooth, finely toothed; radical leaves obovate, undivided, those of the stem lobed, auricled, and partly clasping. *Flower-heads* panicled, with small heart-shaped bracts; *flowers* all ligulate, perfect, light yellow.

Source.—Europe; chiefly produced in Scotland, France, and Prussia.

Description of Drug.—In sections of plano-convex circular cakes, or angular pieces, of a grayish or reddish-brown color, breaking with a waxy, yellowish-white fracture; **odor** opium-like and disagreeable, characteristic; taste bitter and acrid. It is partly soluble in alcohol and ether. When triturated with water it yields a turbid solution; boiling water dissolves about 50 per cent., forming a brown infusion.

Constituents.—Lactucin, lactucopicrin (very bitter and acrid), lactucic acid, $O_{44}H_{32}O_{21}$ (very bitter, probably an oxidation product of lactucopicrin), lactucerin (lactucone), and wax.

Preparation of Lactucerin, Lactucone.—Boiling alcohol extracts it in almost pure state from lactucarium, which has been deprived of resin and caoutchouc.

Action and Uses.—Anodyne, hypnotic, and sedative, **resembling opium in its action, but much feebler** and without the depressing after-effects. Dose: 5 to 60 gr. (0.3 to 4 Gm.).

Official Preparations.

Tinctura Lactucarii (50 per cent.), ...Dose: 10 to 60 ♏ (0.6 to 4 Cc.).
Syrupus Lactucarii (10 per cent. of Tincture), ... ½ to 2 fl. dr. (2 to 8 Cc.).

317. **LACTUCA SATIVA.**—Garden Lettuce. Popularly used as a mild antispasmodic to allay nervous irritability and mental worry. It yields a lactucarium during flowering, but before that period the juice is pellucid and insipid.

318. **LACTUCA CANADENSIS.**—Wild Lettuce. Used as a mild soporific for children. Dose: 20 gr. (1.3 Gm.).

319. **PARTHENIUM.**—Feverfew. The herb of **Matrica'ria parthe'nium** Linné. *Habitat:* Europe; cultivated in this country. Resembles chamomile in odor and taste, in medical properties, and also in the appearance of the flowers, which differ, however, in their peculiar odor, their rounded and somewhat flattened receptacle, and the numerous large and long disk-florets which they bear.

320. **COTULA.**—MAYWEED. WILD CHAMOMILE. The herb of **Anthe'mis cotu'la** Linné. *Habitat:* Europe; naturalized in the United States. It has essentially the same properties as anthemis and chamomile, but has a disadvantage for general use in its strong, disagreeable odor. It is popularly used as a sudorific and antispasmodic, in doses of ½ to 2 dr. (2 to 8 Gm.), in infusion.

FIG. 140.—*Matricaria chamomilla*—Branch and dissected flowers.

321. MATRICARIA.—MATRICARIA.

GERMAN CHAMOMILE. *Ger.* KAMILLENBLUMEN.

The dried flower-heads of **Matrica'ria chamomil'la** Linné.

BOTANICAL CHARACTERISTICS.—*Plant* annual; *stem* 1 to 2 feet high, much branched. *Leaves* alternate, more or less pinnate, smooth. *Heads* solitary; *ray-florets* white, pistillate, spreading, soon reflexed; *disk-florets* deep yellow, perfect; pappus none. The *flowers* have a peculiar aroma and a bitter aromatic taste.

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SOURCE.—Europe and Asia. The genus Matricaria is widely distributed; two or three species of the "wild chamomile" of this genus have been introduced into the United States.

DESCRIPTION OF DRUG.—After drying, the flower-heads are of a dull yellow or yellowish-white color, about 10 mm. ($\frac{2}{5}$ in.) broad, surrounded by a flattish, imbricated involucre; this involucre is composed of oblong scales, having a membranous, translucent margin; the receptacle is conical, internally **hollow,** and bears a single row of about fifteen short, toothed, reflexed ray-florets, and numerous tubular yellow disk-florets, without pappus; **disagreeably aromatic;** taste bitterish, aromatic.

Powder.—Greenish. Characteristic elements: The interesting microscopical constituent for study is found in the pollen grains with three distinct pores; seldom dispensed as powder.

ADULTERATIONS.—*Anthemis arvensis* and *A. cotula* (320). These have solid, chaffy receptacles.

CONSTITUENTS.—Deep blue **volatile oil, anthemic acid, anthemidin,** and tannin.

Preparation of Anthemic Acid.—The concentrated infusion, made with water acidulated with acetic acid, is precipitated with alcohol. The alcoholic residue, after evaporation of the alcoholic solution, is treated with chloroform. The precipitate produced by alcohol contains anthemidin.

ACTION AND USES.—Mild **stimulant** and tonic, in large doses emetic. Dose: 15 to 60 gr. (1 to 4 Gm.) in infusion.

322. ANTHEMIS.—ANTHEMIS.

ROMAN CHAMOMILE. ENGLISH CHAMOMILE.
Ger. RÖMISCHE KAMILLE.

The dried flower-heads of **Anthe'mis nobil'is** Linné, collected from cultivated plants.

BOTANICAL CHARACTERISTICS.—*Roots* perennial; *stems* much branched, furrowed. *Leaves* very finely dissected, clasping the stem. *Flower-heads* solitary, with a convex, yellow disk; *ray-florets* white, perfect; pappus none.

SOURCE.—Europe; cultivated in Germany, England (Mitcham Gardens), Surrey; introduced in United States.

DESCRIPTION OF DRUG.—There are two kinds of flower-heads, the single and the double. The latter is developed by cultivation, the disk-florets being partly or wholly converted into the white, strap-shaped, three-toothed ray-florets, forming an **almost spherical head, dull white** when dry and about 20 mm. ($\frac{4}{5}$ in.) broad; it is the kind preferred, on account of its greater aromatic properties, which reside in

the rays, but as the conversion is more or less incomplete, both kinds may be found intermingled in the commercial article. It is stated, however, by some that the single flowers are more odoriferous and yield a larger proportion of volatile oil; the double flowers, being more showy, are preferred by the public. Involucre imbricate, the scales ovate-oblong, with a scarious margin; receptacle **solid,** conical, chaffy; **odor** strong, agreeable; taste aromatic and bitter.

FIG. 141.—*Anthemis nobilis*—Plant and dissected flowers.

Powder.—Straw color. Characteristic elements: Trichomes, glandular, single-celled, thick-walled; pollen and stomata present.

CONSTITUENTS.—**Volatile oil** (Oleum Anthemidis), at first pale blue, becoming yellowish-brown on exposure; it is regarded as a mixture of hydrocarbons with the angelic, valerianic, and tiglinic esters of butyl and amyl. Anthemis also contains a brown, bitter extractive, probably a glucoside.

ACTION AND USES.—**Stimulant** and tonic, in enfeebled digestion during convalescence; also carminative, and in large doses emetic. Dose: 15 to 60 gr. (1 to 4 Gm.), in infusion.

323. SANTONICA.—SANTONICA.

LEVANT WORMSEED. *Ger.* WURMSAMEN.

The dried unexpanded flower-heads of **Artemis'ia pauciflo'ra** Weber.

BOTANICAL CHARACTERISTICS.—A low, shrubby, tomentose, aromatic plant. *Leaves* downy, pinnatifid; *flower-heads* drooping, in dense thrysoid panicles.

SOURCE.—*Artemisia pauciflora* grows on the desert plains or steppes of several parts of Russia, especially in the districts near the lower course of the Volga and Don Rivers. It is quite abundant in Persia and Turkestan, where it is known as Damanah. This Asiatic drug does not differ materially from the Russian, except that it is slightly shaggy and mixed with tomentose stalks. Of late years most of the wormseed of commerce has come from the steppes of the northern part of Turkestan, whence it finds its way to Moscow and Western Europe.

FIG. 142.—Santonica—Head and longitudinal section enlarged.

DESCRIPTION OF DRUG. — **Greenish-brown, small,** oblong-ovoid, about 2 mm. ($\frac{1}{8}$ in.) long. They consist of fifteen to eighteen imbricated scales, each having a green midrib containing oil-glands, which inclose four or five tubular florets so minute that they can scarcely be distinguished by the naked eye; **odor** strong, aromatic; taste bitter, aromatic, camphoraceous.

Powder.—Greenish-brown. Characteristic elements: Parenchyma cells, elongated, thin-walled; trichomes, glandular, 1 or 2 short cells or two or three pairs of cells, non-glandular, one-celled, long, slender, thin-walled; pollen mostly in masses, brown, 15 to 20 μ in diam.; pores distinct.

CONSTITUENTS.—Volatile oil about 1 per cent., having a characteristic smell and taste, devoid of anthelmintic properties, which reside in the neutral principle, **santonin,** $C_{15}H_{18}O_{31}$. Santonin (Santoninum, U. S.) constitutes about 2 per cent. of the drug; it occurs in colorless, rectangular, tabular crystals, which, when exposed to the light, assume a yellow hue. Soluble in 5300 parts of water, 34 of alcohol, 78 of ether and 2.5 of chloroform at 25° C. (77° F.).

Preparation of Santonin.—Digest powdered santonica in dilute alcohol mixed with slaked lime; recover alcohol; add acetic acid in excess to residue, which separates santonin in white, shining, odorless bitter prisms, turning yellow on exposure.

This important principle is manufactured to a considerable extent in Russia, large factories at Oldberg turning out about twelve tons annually. It is well known to the natives of India, and is now imported from Germany. Much of the imported santonin is adulterated, sometimes to the extent of three-fourths of its weight, with gum and boric acid. These can easily be detected upon

exposure, as santonin turns yellow. The quantity of santonin in the plant diminishes as the plant grows older and the flowers expand.

Tests.—On dissolving with nitric acid and adding sulphuric acid we get a red color, and on adding Fe_2Cl_6 it changes to violet. With an alcoholic solution of KOH a pinkish-red liquid is obtained, soon becoming colorless.

On account of the fact that santonin is easily decomposed, it should be kept in amber-colored bottles, away from the sunlight, which converts it into yellow photo-santonic acid. Heating it with alkalies changes it into santoninic acid, while long boiling with baryta water changes it into santonic acid.

ACTION AND USES.—**Anthelmintic.** Dose: 15 to 60 gr. (1 to 4 Gm.), in infusion or electuary. Dose of santonin: ¼ to 1 gr. (0.016 to 0.065 Gm.), in powder or troches. **Trochisci Santonini,** U. S. P., ½ gr. (0.03 Gm.).

324. CALENDULA.—CALENDULA.

MARIGOLD. *Ger.* RINGELBLUMEN.

The dried ligulate florets of **Calen'dula officina'lis** Linné.

BOTANICAL CHARACTERISTICS.—*Stem* roughish, hairy, 1 to 2 feet high. *Leaves* alternate, sessile, hairy, entire to few-toothed, varying in shape from spatulate or obovate to oblanceolate. *Flower-heads* terminal; *ray-florets* pistillate, fertile, yellow or orange color; *disk-florets* perfect, but sterile.

HABITAT.—Levant and Europe; cultivated in our gardens.

DESCRIPTION OF DRUG.—Florets about 12 mm. (½ in.) long, **linear** and **strap-shaped,** delicately veined in a longitudinal direction, **yellow or orange-colored,** 3-toothed above, the short, hairy tube inclosing the remnants of a filiform style terminating in two elongated branches; odor slight and somewhat heavy; taste somewhat bitter and faintly saline.

SUBSTITUTION.—The *Tagates erecta.* Much of the fluidextract of calendula on the market at present is really obtained from the above and from *T. patula* (Natl. Disp.).

CONSTITUENTS.—Trace of volatile oil, a bitter principle, and a peculiar gummy principle, calendulin, $C_6H_{10}O_5$, regarded by some authorities as analogous to bassorin.

ACTION AND USES.—It has slight stimulant and diaphoretic properties, but is used principally in the form of tincture, as a **vulnerary.** Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATION.

Tinctura Calendulæ (20 per cent.), ... Dose: 1 to 4 fl. dr. (4 to 15 Cc.).

325. **CARTHAMUS.**—SAFFLOWER. AMERICAN SAFFRON. The florets of **Cartha'mus tincto'rius** Willdenow. (Official, 1820–1880.) *Habitat:* India, Levant, and Egypt; cultivated. **Orange-red;** tube long, slender, cylindrical, with the two-cleft yellowish style protruding; strap divided into five narrow, lanceolate lobes; odor peculiar, aromatic; taste bitter. It contains two coloring principles, safflower-yellow, $C_{24}H_{30}O_{15}$ (24 to 30 per cent.), and a red principle, carthamin, $C_{14}H_{16}O_7$, or carthamic acid, to

the latter of which its value as a dyestuff is due, and which, mixed with talc, forms rouge. Cathartic and diaphoretic in large doses of the warm infusion; in domestic practice used as a substitute for saffron to promote eruption in measles, scarlatina, etc. Dose: 8 to 15 gr. (0.5 to 1 Gm.).

326. **HELIANTHUS ANNUUS** Linné.—Our common sunflower, the seeds of which are sometimes used as a diuretic and expectorant in pulmonary and laryngeal affections. Dose of fluidextract: 1 to 2 fl. dr. (4 to 8 Cc.). The fixed oil expressed from them has become an article of commerce, and the growing plants themselves enjoy the reputation of purifying malarial districts

CAMPANULACEÆ.—Campanula Family.

Herbs or shrubbery plants, with acrid, milky juice, alternate *leaves*, and scattered flowers, *corolla* 5-lobed. *Fruit* a one- to several-celled capsule. Many species of the tribe Lobeliæ are acrid-narcotic poisons.

327. LOBELIA.—Lobelia.

INDIAN TOBACCO. *Ger.* LOBELIENKRAUT.

The dried leaves and tops of **Lobe'lia infla'ta** Linné, collected after a portion of the capsules have become inflated.

Botanical Characteristics.—*Stems* much branched from an annual root, pubescent; *leaves* ovate or oblong, gradually diminishing into leaf-like bracts. *Capsule* inferior.

Related Species.—*Lobelia syphilitica* (great lobelia), *Lobelia cardinalis* (cardinal plant).

Habitat.—United States.

Description of Drug.—In the market the herb is broken up, but the fragments of green leaves, small pieces of the longitudinally-ridged stem, the rather elongated, dried flowers, and the inflated, membranous capsules serve to identify it; **odor** irritating when inhaled; taste very pungent, persistently acrid, and tobacco-like.

Powder.—Brownish-green. Characteristic elements: Walls of upper epidermal cells, porous; sclerenchyma with bast fibers, thin-walled, slightly lignified; trichomes, one-celled (3 to 10 by 6 to 10 μ in diam.), pollen and stomata present; calcium oxalate in prisms.

Constituents.—**Lobeline** (a poisonous, acrid, yellowish, aromatic liquid alkaloid), **lobelic acid, lobelacrin** (an active principle, probably lobelate of lobeline), inflatin (a tasteless, colorless, and odorless, probably inert, neutral principle), resin, fixed oil, gum, probably volatile oil, salts, etc.

Preparation of Lobeline.—Evaporate the acetic alcoholic tincture to syrup; triturate this with MgO in excess; agitate filtrate with ether. Evaporate ether and concentrate over sulphuric acid. It is quite volatile.

Preparation of Lobelacrin.—Obtain by concentrating tincture of lobelia in

presence of animal charcoal; exhaust charcoal with boiling alcohol. It is the acrid principle, lobelate of lobeline (?).

ACTION AND USES.—Poisonous; diaphoretic and expectorant; used in **asthma,** whooping-cough, and other spasmodic pulmonary affections. In large doses it is a cathartic and emetic, but, being a violent gastro-irritant, **it should not be used for these purposes on account**

FIG. 143.—*Lobelia inflata*—Portion of plant and flower.

of its danger. Dose: 1 to 15 gr. (0.065 to 1 Gm.). The latter dose as an emetic. The two species, *syphilitica* and *cardinalis*, are used medicinally, the former antisyphilitic and diaphoretic and the latter anthelmintic. Both were used by the Indians.

OFFICIAL PREPARATIONS.

Fluidextractum Lobeliæ, ... Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.).
Tinctura Lobeliæ (10 per cent.), ... Expectorant 15 ♏ (1.0 Cc.),
Emetic 1 fl. dr. (4.0 Cc.).

ERICACEÆ.—Heath Family.

Trees or shrubs, rarely herbs; *leaves* generally foliaceous; *flowers* regular, gamopetalous, usually bell-shaped or urn-shaped; *anthers* two-celled, with porous dehiscence. A large order, with *leaves* astringent and bitter, because of the presence of glucosides. Some species contain a poisonous principle, andromedotoxin.

Synopsis of Drugs from the Ericaceæ.

A. *Leaves.*
- **UVA URSI,** 328.
- Arctostaphylos, 329.
- Gaultheria, 330.
- **CHIMAPHILA,** 331.
- Epigæa, 332.
- Vaccinium, 333.
- Kalmia, 334.
- Ledum, 335.
- Oxydendrum, 336.
- Rhododendron, 337.

B. *Volatile Oil.*
- **OLEUM GAULTHERIÆ,** 340.

328. UVA URSI.—Uva Ursi.

BEARBERRY. *Ger.* BÄRENTRAUBE.

The dried leaves of **Arctostaph'ylos u'va ur'si** Sprengel.

Botanical Characteristics.—Shrubs with trailing stems. *Leaves* alternate, coriaceous, evergreen, obovate or spatulate, entire. *Flowers* in terminal racemes, nearly white; *corolla* urn-shaped. *Fruit* a red drupe.

Source.—In dry, sandy, or rocky soil from Hudson's Bay to New Jersey, in some parts of which it grows in abundance.

Related Species.—*Arctostaphylos glauca*, indigenous to California (329).

Description of Drug.—**Short-stalked, rather thick, coriaceous, obovate leaves,** about 20 mm. ($\frac{4}{5}$ in.) in length, rounded at the apex and narrowed at the base; margin entire; surface smooth, glossy, grayish-green above, lighter colored and reticulated below; taste astringent, bitter; odor slight. (The powder has a hay-like odor.)

They are sometimes adulterated with the leaves of *Vaccinium vitis ideæ* (European uva ursi), distinguished from the genuine by their rounder shape, their revolute margin, which is sometimes toothed, and the dotted appearance of their under surface. Chimaphila leaves, which are occasionally mixed with uva ursi, may be readily distinguished by their greater length, their cuneiform-lanceolate shape, and their serrate edges. *Leiophyllum buxifolium* (sand myrtle) and *Epigæa repens* (trailing arbutus, 144) are also used as adulterants.

Powder.—Greenish-brown. Characteristic elements: Parenchyma of leaf with irregular, yellowish tannin masses, and prisms of calcium oxalate, the latter sometimes in fibers; trichomes rarely present.

CONSTITUENTS.—**Tannic and gallic acids,** and the three principles, **arbutin,** $C_{12}H_{16}O_7$, **ericolin,** $C_{34}H_{56}O_{21}$, and **ursone,** $C_{10}H_{16}O$, which are common to the plants of the natural order Ericaceæ. Arbutin is a bitter glucoside, occurring in colorless crystals; it is resolved by hydrolysis into glucose and hydroquinone or arctuvin, $C_6H_6O_2$. Ericolin is a yellow, crystalline, bitter glucoside. Ursone is in tasteless needles.

Preparation of Arbutin.—Precipitate decoction with lead acetate; filter; add H_2S; evaporate; evaporate slowly, when needles crystallize out. Dilute Fe_2Cl_6 gives blue color. Dose: 5 to 15 gr. (0.3 to 1 Gm.).

FIG. 144.—*Arctostaphylos uva ursi*—Branch, flower, and fruiting branch.

Preparation of Ursone.—Obtained by exhausting drug with ether. The alcoholic solution of the ethereal residue yields the crystals on slow evaporation. Occurs in tasteless needles; sparingly soluble in alcohol and ether. Insoluble in water.

ACTION AND USES.—Astringent, tonic, and **diuretic;** valuable in ulcerations of the kidneys, bladder, or urinary passages. It has been recommended in cystitis, its action being due to the decomposition of arbutin in the system and the excretion of the hydroquinone, which is a powerful disinfectant and antiferment. Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Uvæ Ursi,.............Dose: 15 to 60 ♍ (1 to 4 Cc.).

329. **ARCTOSTAPHYLOS GLAUCA** Lindley.—MANZANITO. This is a small California evergreen tree or shrub whose leaves are there highly esteemed as an astringent, like uva ursi.

330. **GAULTHERIA.**—WINTERGREEN. CHECKERBERRY. PARTRIDGE BERRY. The leaves of **Gaulthe'ria procum'bens** Linné. *Habitat:* Northern Hemisphere. This is a small evergreen shrub, consisting of slender, erect, reddish stems, bare below, leafy at top, rising at intervals from a creeping root to the height of eight or ten inches. Fruit a scarlet-red, berry-like, fleshy capsule. **Leaves** roundish, oval or obovate, about 37 mm. (1½ in.) long, on a short pedicel; coriaceous; margin serrate, with a few **appressed teeth;** somewhat revolute at the edges; **odor** fragrant, especially when chewed; taste aromatic, astringent. The fragrance is due to a volatile oil (330 a). Stimulant, astringent, and **diuretic.** Dose: 15 to 60 gr. (1 to 4 Gm.).

330 a. **OLEUM GAULTHERIÆ,** U. S.—OIL OF WINTERGREEN. A nearly colorless volatile oil, distilled from the fresh leaves, "consisting almost entirely of methyl salicylate, $CH_3C_7H_5O_3$, and nearly identical with volatile oil of betula" (U. S.). The latter, according to Power, is composed entirely of methyl salicylate and is optically inactive, while the former is lævogyrate. As it comes into market it is of a brownish-yellow or reddish color and has a very agreeable, characteristic odor and taste. It is remarkable in having the high **specific gravity of 1.175–1.185.** An aqueous solution gives, with ferric salts, a purplish color. It yields, with 6 parts of 70 per cent. alcohol at 20° C., a perfectly clear solution—a property serving to detect adulterations (**Spiritus Gaultheriæ,** U. S. P., 5 per cent.).

331. CHIMAPHILA.—CHIMAPHILA.

PIPSISSEWA. PRINCE'S PINE.

Ger. DOLDENBLÜTHIGES HARNKRAUT.

The dried leaves of **Chimaph'ila umbella'ta** Nuttall.

BOTANICAL CHARACTERISTICS.—A low, nearly herbaceous plant, with long, running, underground shoots. *Leaves* evergreen, thick, and shining, whorled, wedge-lanceolate, sharply serrate, not spotted. *Flowers* umbelled, on a terminal peduncle; *petals* rose-color; *anthers* violet. *Capsule* 2- to 5-celled.

HABITAT.—Northern Hemisphere, in dry woods.

DESCRIPTION OF DRUG.—**Oblanceolate,** about 25 to 50 mm. (1 to 2 n.) in length, **sharply serrate,** with pointed apex, **cuneiform** and entire at base; coriaceous; surfaces smooth, upper dark green, glossy, lower lighter in color; odor slight; taste astringent, slightly bitter.

Chimaphila maculata (spotted wintergreen or pipsisseway) has the

same medicinal qualities, but differs physically in being oval-lanceolate, with a paler upper surface, and in being dotted with small white holes along the midrib.

RELATED PLANTS.—*Pyrola rotundifolia* (known as wintergreen or shin leaf), *P. elliptica* and *P. chlorantha* are used similarly to the above.

Powder.—Brownish-green. Characteristic elements: Parenchyma, mesophyll with irregular reddish-brown tannin masses, other cells with few starch grains, simple or compound, calcium oxalate crystals, aggregate (40 to 60 μ in diam.); stomata and few tracheids present.

FIG. 145.—*Chimaphila umbellata.*

CONSTITUENTS.—Same as uva ursi (328) with the addition of chimaphilin, $C_{24}H_{21}O_4$ (yellow, odorless, tasteless, volatile crystals), and several white crystalline principles.

Preparation of Chimaphilin.—When the leaves are distilled with water, yellow crystals are deposited in the neck of the retort. These, dissolved out with chloroform, will deposit from this solution on evaporation. Shaking out the tincture with chloroform will also dissolve out the principle.

ACTION AND USES.—Like uva ursi (328). Also used in scrofula and other cutaneous eruptions. Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Chimaphilæ, ...Dose: 15 to 60 ♏ (1 to 4 Cc.).

332. **EPIGÆA.**—TRAILING ARBUTUS. GRAVEL PLANT. The leaves of **Epigæ'a re'pens** Linné. *Habitat:* North America, on woody hillsides. Ovate, about 50 mm. (2 in.) long, with heart-shaped base and mucronate apex; coriaceous; margin entire. They contain the same three principles that uva ursi does and have the same general medicinal properties, but are particularly valuable in those cases of local irritation of the urinary organs in which they have often given relief when uva ursi and buchu had failed. They are also claimed to be highly beneficial in lithic acid gravel. Dose: 15 to 60 gr. (1 to 4 Gm.), in decoction or fluidextract.

333. **VACCINIUM CRASSIFOLIUM** Andrzejowski.—The leaves of this indigenous shrub have properties very much resembling uva ursi and may be used in its stead.

334. **KALMIA.**—MOUNTAIN LAUREL. SPOONWOOD. The leaves of **Kal'mia latifo'lia** Linné, an evergreen shrub common on the hills and mountains of North America. They are lance-oval, acute at both ends, about 50 to 75 mm. (2 to 3 in.) in length; petiolate; coriaceous; both surfaces smooth, green. In medicinal doses kalmia is astringent, sedative to the heart, and antisyphilitic; also used externally in skin diseases. From its affirmed effect upon sheep and other small animals it is supposed to have toxic, narcotic properties, but no such principle has yet been found. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

335. **LEDUM.**—LABRADOR TEA. The leaves of **Le'dum latifo'lium** Aiton. *Habitat:* Canada and Northern States. Elliptic-oblong, covered beneath with a rust-colored wool. Besides the tannin and other principles common to the Ericaceæ, they contain a poisonous principle, andromedotoxin, rendering them poisonous in large doses. Astringent, tonic, and alterative. Dose: 15 to 30 gr. (1 to 2 Gm.), in infusion.

336. **OXYDENDRUM ARBOREUM** De Candolle.—SOURWOOD. The leaves of this North American tree are tonic, diuretic, and refrigerant, used in dropsy. Dose of fluidextract: ½ to 2 fl. dr. (2 to 8 Cc.).

337. **RHODODENDRON MAXIMUM** Linné.—GREAT LAUREL. (Leaves.) Tonic, diuretic, astringent, expectorant. Dose of fluidextract: 5 to 15 gr. (0.3 to 1 Gm.).

PLUMBAGINEÆ.—Leadwort Family.

338. **STATICE.**—MARSH ROSEMARY. The root of **Stat'ice limo'nium** Linné, growing in flat marshes along the Atlantic coast of the United States. Spindle-shaped, from 300 to 600 mm. (12 to 24 in.) long, and about 25 mm. (1 in.) thick; externally rough, purplish-brown; bark thick; wood yellowish, in narrow wood-wedges; inodorous; bitter and strongly astringent. It contains about 12 per cent. of tannin and is used like catechu and kino in diarrhea, but more particularly as an astringent gargle in ulcerations of the mouth and throat, and as an injection. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

339. **BAYCURU.**—The root of **Statice brasilien'sis** Boissier. *Habitat:* Brazil. One of the most powerful of astringents, chiefly used locally in gargle, injection, and lotion.

PRIMULACEÆ.—Primrose Family.

340. **ANAGALLIS ARVENSIS** Linné.—SCARLET PIMPERNEL. This plant, growing in the United States and Europe, is applied locally to ulcers and employed internally in consumption, dropsy, etc. It contains a pepsin-like ferment.

MYRSENEÆ.

341. **EMBELIA RIBES** Burman.—The pepper-corn-like, aromatic fruit of this East Indian plant is said to be an efficient tæniafuge.

SAPOTACEÆ.—Sapodilla Family.

342. **GUTTA-PERCHA.**—The concrete juice of large trees, **Isonandra** (or *Palaquium oblongifolium*), **Dichop'sis gut'ta,** and other species, growing in the Malay Peninsula and the East Indies. In grayish or yellowish masses, often streaked with red; hard and tenacious at ordinary temperatures, with a somewhat unctuous feeling, but at a higher temperature, or when immersed in hot water, it becomes plastic, retaining, when hard and dry, the form into which it has been molded. Upon this property its uses in the arts chiefly depend. In medicine it is used as a surgical dressing in the formation of splints, supports, etc. A Liquor Guttæ Perchæ (U. S. P., 1880) is often applied as a protective, the evaporation of its solvent, carbon disulphide, leaving a thin, flexible coating over the wounded surface.

343. **MONESIA.**—An extract obtained from a South American tree, **Lucu'ma glycyph'læa** Martius et Eichler. Dark brown, almost black, cakes, about 25 mm. (1 in.) in thickness; very brittle, often coming into the market in broken fragments; inodorous; taste sweetish, astringent, and then acrid, its acrimony being very persistent, especially in the fauces. This acridity is due to **monesin,** a principle identical with saponin. Monesia also contains tannin, glycyrrhizin, and lucumin (silky needles). Stomachic stimulant, alterative, and astringent. Used in diarrhea, hemorrhages, in astringent gargles, and in powder or ointment applied to scrofulous ulcers. Dose: 5 to 20 gr. (0.3 to 1.3 Gm.).

EBENACEÆ.—Ebony Family.

344. **DIOSPYROS.**—Persimmon. The unripe fruit of **Dio'spyros virginia'na** Linné. (Official, 1820–'80.) Very astringent. Used in uterine hemorrhage, leucorrhœa, and sore throat. Dose: 15 to 60 gr. (1 to 4 Gm.) in infusion, syrup, or vinous tincture.

STYRACEÆ.—Storax Family.

345. BENZOINUM.—Benzoin.

BENZOIN. *Ger.* BENZOË.

A balsamic resin obtained from **Sty'rax ben'zoin** Dryander, and other species of styrax.

Botanical Characteristics.—A large tree with tomentose branches. *Leaves* alternate, oblong, the under surface tomentose. *Inflorescence* compoundly racemose; *calyx* 5-toothed; *corolla* 5-parted, gray; *stamens* 10, their filaments coherent at the base into a short tube.

Source and Varieties.—Sumatra and Java. Sumatra-Penang, grayish-brown with many white tears, odor storax-like; Siam, reddish-brown, odor vanilla-like; Palembang resembles Sumatra, but yields more benzoic acid; false benzoin, catappa benzoin (*Terminalia angustifolia*), whitish brown.

A deciduous shrub of the Lauraceæ, a native of Virginia, and called spice-wood or Benjamin tree, was at one time thought to be a source of benzoin. The berries of this tree are aromatic, and have been used as a substitute for allspice.

COLLECTION.—In Sumatra the benzoin is collected by making incisions in the tree during its seventh year, only the unhealthy trees yielding resin. The milky juice which flows first is the purest and most

FIG. 146.—*Styrax benzoin*—Branch.

fragrant, but soon hardens upon exposure to the air. That which flows subsequently is brownish, and some is scraped out when the tree is cut down and split open, as it is soon killed by the process of tapping. These varieties are in common called head, belly, and feet benzoin, and have the relative value to each other of 105, 45, and 18, being esteemed according to their whiteness, semi-transparency, and freedom from admixture (Royle). A product of the

younger tree furnishes a variety known as amygdalina benzoin, which contains whitish, almond-like tears diffused through its substance.

Description of Drug.—It exudes from incisions in the bark, hardening on exposure into agglutinated shining tears of a yellowish-brown or reddish-brown color; internally milk-white; usually, however, it is in various-sized pieces, having a resinous fracture, showing a **mottled surface** of smooth, shining white spots, tears, imbedded in the somewhat rough and porous, reddish-brown mass. It has a very agreeable **odor** and a slightly aromatic taste, leaving an irritating sensation in the mouth and fauces.

Constituents.—Benzoin has the constitution of a balsam and is by some authors considered as a solid balsam; it contains resin, benzoic acid, $C_7H_6O_2$, 20 to 24 per cent., which comes off in dense white vapor when benzoin is heated and melted, and cinnamic acid, $C_9H_8O_2$ (in some varieties), detected by boiling in milk of lime, decomposing with HCl, and adding permanganate of potassium, when the odor of bitter almonds is given off. Siam benzoin contains vanillin, $C_8H_8O_3$, and has a vanilla-like odor.

Preparation of Benzoic Acid.—Obtained by simple sublimation of benzoin. Is also prepared artificially from tuluol, but sometimes from phthalic acid or hippuric acid. The U. S. P. provides against its contamination with cinnamic acid. When this impurity is present, mild oxidation yields the odor of oil of bitter almond. (See above.)

Action and Uses.—Stimulant and diaphoretic, but seldom used as such except in the compound tincture of benzoin. It is used locally as a stimulant and irritant, and in tooth powders and fumigations. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

Official Preparations.

Tinctura Benzoini Composita (10 per cent., with aloes, storax, and tolu), ...	Dose: 15 to 60 ♍ (1 to 4 Cc.).
Tinctura Benzoini (20 per cent.), ...	10 to 40 ♍ (0.6 to 2.6 Cc.).
Adeps Benzoinatus (2 Gm. digested in 100 Gm. of lard).	

OLEACEÆ.—Olive Family.

Trees or shrubs with simple leaves—illustrated by the olive, the ash, the lilac, and the privet. The olive fruit contains mannite, which is converted into olive oil on ripening.

346. MANNA.—Manna.

MANNA. *Ger.* MANNA.

The concrete saccharine exudation from **Frax'inus or'nus** Linné.

Botanical Characteristics.—A tree about 25 feet high. *Leaves* pinnate, *leaflets* 7 to 9, serrate. *Panicles* dense; *calyx* 4-cleft; *corolla* white, divided to the base into linear segments.

SOURCE.—The tree yielding the manna is a native of Sicily, Calabria, and Apulia. The juice exudes spontaneously, or its flow is hastened by incision. Although this is the only manna officially recognized, saccharine substances known as mannas are yielded by many other trees and plants, and are obtained from the cocoons of some insects. The manna of Scripture was doubtless a lichen which grows extensively in the Sahara and Western Asia, and which occasionally falls like rain over the adjacent country.

DESCRIPTION OF DRUG.—In stalactiform pieces from 1 to 6 inches long, or irregular fragments, **yellowish or brownish-white,** internally white and porous; very friable. Manna in tears is a pure kind, but manna in flakes is chiefly valued and mostly met with. Manna in sorts, minute tears, internally crystalline, and fat manna, brownish, viscid, non-crystalline masses, are also met with. **Odor honey-like; taste** sweetish, afterward nauseous. Soluble in water and alcohol. When long kept, manna darkens and deliquesces into a liquid.

OTHER MANNAS.—The sweet exudation of various trees, some of which, being different from the manna ash, have received the name of manna; hence we have the exudation from a eucalyptus, yielding *Australian manna*, *Persian manna* from a leguminous plant, *Lebanon manna* from *Cedrus libanotica*,—all of which are saccharine exudations containing the sugar peculiar to this drug. Some of the exudations result from the puncture of insects, some spontaneous exudations, others from incisions.

CONSTITUENTS.—Chiefly **mannite** (75 per cent.), a sweet principle which separates out from the boiling alcoholic solution in crystals, also sugar, dextrin, mucilage, and a **nauseous principle,** to which its laxative action is doubtless due.

ACTION AND USES.—**Gentle laxative,** usually given in combination with other purgatives. Dose: ½ to 2 oz. (15 to 60 Gm.).

OFFICIAL PREPARATION.

Infusum Sennæ Compositum, 12 per cent.), ...Dose: 1 to 4 fl. oz. (30 to 120 Cc.).

347. OLEUM OLIVÆ.—OLIVE OIL.

SWEET OIL. *Ger*. OLIVENÖL.

A fixed oil expressed from the ripe fruit of **O'lea europæ'a** Linné.

BOTANICAL CHARACTERISTICS.—A small evergreen with hard wood. *Leaves* short-petiolate, opposite, ovate-lanceolate, mucronate. *Flowers* white, in axillary clusters. *Fruit* a drupe, ½ to 1 in. long, ovoid, purple; sarcocarp firm, fleshy, filled with oil.

HABITAT.—Levant and the Mediterranean Basin and California.

DESCRIPTION OF OIL.—A pale yellow or greenish-yellow, unctuous liquid when pure, having a bland, sweetish taste, but scarcely any odor. Specific gravity 0.915 to 0.918 at 15° C., 59° Fahr. On exposure it absorbs oxygen and becomes thick and rancid and loses its color, but does not dry as does linseed oil. See Tests in U. S. P.

The oil is obtained by crushing the ripe fruit and subjecting the

FIG. 147.—*Olea europæa*—Branch.

pulp to strong pressure. The expressed oil is run into water and the floating oil is skimmed after a few days' subsidence (virgin oil); the expressed cake is now broken up, mixed with hot water, and again subjected to pressure, resulting in a second-grade oil. The remaining marc yields by solvents, such as carbon disulphide, or by a third expression after fermentation, a very inferior oil.

The oil is adulterated with cotton-seed oil chiefly, with oil of benne (408 a), and with peanut oil.

Preparations:

Sapo, soap (which is employed in:
Linimentum saponis. Emplastrum saponis.)
Emplastrum plumbi: lead acetate, and soap solution are mixed and the resulting precipitate is kneaded on a warm slab to free the mass from water.
Emplastrum adhæsivum contains emplastrum plumbi, rubber, and petrolatum.
Unguentum diachylon, ...50 per cent.

From the olive is obtained the wood so famous for its capability of receiving a fine polish; used in cabinetwork of various kinds. The unripe fruit is served at the table. It is prepared by repeatedly steeping it in water containing lime and ashes, then bottling in a slightly aromatic salt solution; the small French or Provence, the finest, and the large Spanish are both used for this purpose.

CONSTITUENTS.—At about 5° C. (41° F.), white crystalline granules separate out, which consist of palmitin with possibly some stearin and arachin. The liquid portion remaining consists almost entirely of olein, $C_3H_5(OC_{18}H_{33}O)_3$, which forms about 72 per cent. of the oil. The green color is due to chlorophyll.

ACTION AND USES.—Nutritive and laxative, a common ingredient in laxative enemata; externally **protective and emollient.** Its chief use in pharmacy is in liniments, cerates, and plasters. Dose: 1 fl. oz. (30 Cc.).

348. **FRAXINUS AMERICANA** Linné.—WHITE ASH. (Root-bark.) Quills or curved pieces, having an ash-gray periderm and a white inner bark, and breaking with a splintery, coarsely fibrous fracture. Emmenagogue. Dose: about 15 gr. (1 Gm.).

349. **FRAXINUS SAMBUCIFOLIA** Lambert.—BLACK ASH. (Bark.) *Habitat:* United States. Tonic and astringent. Dose: 1 to 4 dr. (4 to 15 Gm.).

350. **CHIONANTHUS.**—FRINGE-TREE. The root-bark of **Chionan'thus virgin'ica** Linné. *Habitat:* United States. Tonic, aperient, and diuretic. Dose: 15 to 60 gr. (1 to 4 Gm.).

351. **LIGUSTRUM.**—PRIVET. The leaves of **Ligus'trum vulga're** Linné, a shrub growing wild in the United States and Europe. Astringent; the decoction is used in sore throat, ulcerations of the mouth, stomach, and intestines.

APOCYNACEÆ.—Dogbane Family.

Herbs, shrubs, or trees, mostly tropical, with a milky juice which is often drastic or poisonous. *Leaves* mostly opposite, exstipulate. *Flowers* regular, 5-merous and 5-androus, with the pollen cohering into granular, waxy masses. *Fruit* a pair of follicles; seeds often comose.

Synopsis of Drugs from the Apocynaceæ.

A. *Roots.*
  APOCYNUM, 352.
  Apocynum Androsæmifolium, 352 a.

B. *Barks.*
  Aspidosperma, 353.
  Alstonia Constricta, 354.
  Alstonia Scholaris, 355.
  Conessi, 356.

C. *Seeds.*
  STROPHANTHUS, 357.

D. *Leaves.*
  Oleander, 358.

E. *Herb.*
  Urechites, 359.

Powder.—Pale brown. Characteristic elements: Parenchyma of cortex with single starch grains (7 to 15 μ in diam.); sclerenchyma with bast fibers, numerous, stone cells, sometimes present; ducts, large and small, porous, reticulate and annular; laticiferous vessels in yellowish fragments. Androsæmifolium has more stone cells; cork tissue in small amount.

352. APOCYNUM.—Apocynum.

CANADIAN HEMP. *Ger.* CANADISCHE HANFWURZEL.

The dried rhizome of **Apocy'num canna'binum** Linné and closely allied species.

Botanical Characteristics.—*Stems* much branched, 2 to 3 feet high. *Leaves* from oval to oblong or lanceolate, short petiolate or sessile. *Inflorescence* cymose; *corolla* greenish-white, with nearly erect lobes, the tube not longer than the calyx tube.

Habitat.—United States.

Description of Drug.—A long, cylindrical root, **somewhat contorted,** about 8 mm. ($\frac{1}{3}$ in.) thick, with a **rather thick light brown**

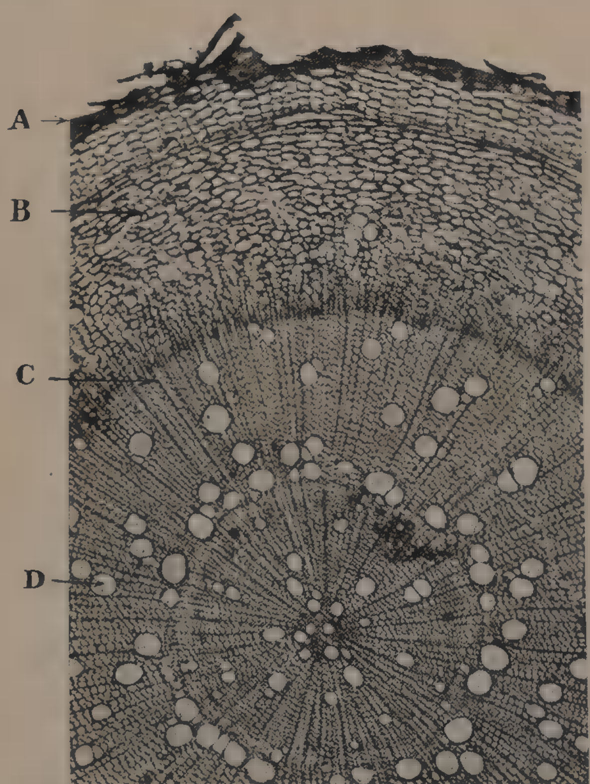


Fig. 148.—*Apocynum cannabinum*—Cross-section. (28 diam.) A, Cork. B, Parenchyma of cortex. C, Medullary ray. D, Water tube. (Photomicrograph).

bark, longitudinally wrinkled and transversely fissured, and a **yellowish, porous wood divided by fine medullary rays** into very narrow wood-wedges; fracture short. The thick inner cortical

layer has numerous lactiferous vessels scattered through it, which in the fresh state secrete a milky juice which hardens into a caoutchouc-like substance. Odor slight, or none; **taste** bitter, nauseous.

Apocynum androsæmifolium Linné, dogbane, resembles the above, but has a relatively thicker bark inclosing a white, porous wood, and contains, in the outer portion, stone-cell groups. By applying the phloroglucin test to a section, the groups of stone-cells are revealed, stained red. Two species sold indiscriminately.

CONSTITUENTS.—**Apocynein,** a yellowish glucoside (acting like digitalin); **apocynin,** a bitter, resin-like extractive; tannin, resin, starch, etc.

ACTION AND USES.—**A valuable diuretic** in moderate doses, in large doses emetic and cathartic, producing considerable diaphoresis and expectoration; most used and most beneficial **in dropsy.** Recently the drug has attracted some attention as a most valuable deobstruent in relieving renal congestion in the second stage of tubular nephritis. It is also a decided heart tonic. Dose as a diuretic, 4 to 5 gr. (0.3 to 0.324 Gm.); as an emetic and cathartic, 15 to 30 gr. (1 to 2 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Apocyni, ...Dose: 15 ♏ (1 Cc.).

353. **ASPIDOSPERMA.**—QUEBRACHO. The bark of **Aspidosper'ma quebra'cho blancho** Schlechtendal. Off. U. S. P. 1890. Thick, flat pieces (from $\frac{2}{5}$ to 1 in. in thickness), with a very thick, yellowish-gray cork, which constitutes more than one-half of its entire substance, and is separated from the lower layer by more or less sharply defined outline, deeply fissured, and traversed by parallel yellowish lines; between these lines are whitish dots visible in a cross-section scattered through both the outer and inner layers. Internally reddish-brown to yellow; odor slight; taste aromatic and bitter. *Constituents:* Aspidosperma is very rich in alkaloids, six having been discovered thus far; the most important are **aspidospermine,** $C_{22}H_{30}N_2O_2$, and **quebrachine,** $C_{21}H_{26}N_2O_2$. A peculiar sugar, quebrachite, is also present, and tannin, 3 to 4 per cent. Cardiac tonic. **Its special action, however, is upon the respiration,** lessening the rate and increasing the amplitude of the respiratory movements; it is chiefly used in asthmatic dyspnœa. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

Preparation of Aspidospermine.—Treat alcoholic extract with alkaline chloroform; dissolve chloroformic extract in acidulated (H_2SO_4) water and precipitate with NaOH; dissolve precipitate (mixed alkaloids) in boiling alcohol and cool, when alkaloids will crystallize.

To separate aspidospermine, crystallize from dilute HCl, when this alkaloid will remain in the mother liquor, from which it may be removed by neutralization and recrystallization. As found in commerce, this alkaloid is a mixture of this and the other associated principles, among which quebrachine is the most important. Crude aspidospermine sulphate is a commercial article, is deliquescent and unstable; it is much more soluble in water than the alkaloid.

Fluidextractum Aspidospermatis, U. S. P. 1890. Dose: 5 to 30 ♏ (0.3 to 2 Cc.).

354. **ALSTONIA CONSTRICTA** F. Mueller.—AUSTRALIAN FEVER BARK. Tonic, antiperiodic. Dose of fl'ext.: 2 to 8 ♏ (0.13 to 0.5 Cc.).

355. **ALSTONIA SCHOLARIS** R. Brown.—DITA. A tree growing in the Philippine Islands, the bark of which is used in India as a substitute for cinchona. Dose of fl'ext.: 2 to 8 ♍ (0.13 to 0.5 Cc.).

356. **CONESSI.**—The bark of **Holar'rhena antidysenter'ica** Wallr. Has been used in Europe and is still extensively employed in India in dysentery. Its alkaloid, conessine, enters commerce.

357. STROPHANTHUS.—STROPHANTHUS.

STROPHANTHUS. *Ger.* STROPHANTHUSSAMEN.

The ripe seed of **Strophan'thus Kombé** De Candolle, deprived of its long awn.

BOTANICAL CHARACTERISTICS.—A woody climber, ascending to the tops of high trees, from which it hangs in festoons. *Flowers* in terminal cymes, gamopetalous, the lobes prolonged into long, tail-like points, often 8 or 9 inches long. *Fruit* two long follicles.

SOURCE.—The genus Strophanthus contains about 20 species, native of Africa and Asia, where it is probable that more than one of them are used for the preparation of arrow-poison.

COMMERCIAL VARIETIES.—Several varieties are found in the market. Jelliffe says ("Drug. Circ.," 1896, p. 101): "It may be expected that as time goes on more and more of the 28 or more species will find their way into trade." *S. hispidus* and *S. kombé* are considered by some writers as varieties of the same species. These are above described. *S. asper* varies from ½ to ¾ of an inch in length, oblong, laterally flattened, and covered with a dense coat of whitish or greenish hairs, which double the diameter of the seed proper. Beneath the hairs the seed is of a light brownish color. *S. gratus*, a smooth, brownish seed from ⅖ to ¾ of an inch in length, slightly fusiform, flattened, and thin; color light, waxy, and dull; often twisted, showing on the posterior surface a long, delicate raphe running from just below the center.

DESCRIPTION OF DRUG.—According to Jelliffe, the seeds of *hispidus* vary from ⅖ to ¾ of an inch in length. The variety *kombé* is apt to be longer, ¾ to 1 inch. The color varies considerably—at times it is brownish-white. Many good seeds are distinctly brown. All are provided with short, stout hairs, pointing upward, which give a shining appearance to the seed. In the case of Kombé seeds, which are apt to be green, the sheen is often well marked. The seeds are flattened, sharp at the apex where the barb is broken off, and narrowed at the lower end. On the back of the seed a fine ridge may often be seen running from the lower third upward. Odor, faintly unpleasant, due to fixed oil; taste very bitter, due to strophanthin.

Powder.—Dark brown. Some of the predominating elements to be studied are: The long, one-celled, non-lignified hairs, which, according to Kraemer,

contain in S. Kombé, colorless or yellowish-green granules, in S. hispidus, dark-brown granules. Sulphuric acid colors *S. Kombé* green, other kinds are usually colored red, on cross-section.

Constituents.—Its medical properties depend upon an intensely bitter glucoside, **strophanthin,** $C_{32}H_{48}O_{16}$ (anhydrous), 2 to 2.5 per cent., choline, trigonelline, kombic acid, resin, mucilage, and a fixed oil are also present.

Fig. 149.—*Strophanthus hispidus*—Branch and seed with comose awn.

Preparation of Strophanthin.—Treat powdered seeds with acidulated (HCl) alcohol; evaporate to soft extract; treat with water. The aqueous solution containing tannate is treated with lead oxide, and from the purified aqueous solution white crystals are obtained.

Action and Uses.—Used in all forms of cardiac disease to supplant digitalis, but is not generally regarded as its equal. It has a diuretic action similar to digitalis through its action on the circulation, and also by direct promotion of urinary secretion, and is especially indicated in cardiac dropsy as being superior to digitalis; given in the form of tincture. Dose: 1 gr. (0.065 Gm.).

Official Preparation.

Tinctura Strophanthi (10 per cent.),.....Dose: 4 to 8 ♏ (0.25 to 0.50 Cc.).

358. **OLEANDER.**—The leaves of **Ne'rium odor'um,** a heart stimulant belonging to the digitalis group. Oleandrin is a cardiac poison.

359. **URECHITES.**—Yellow-flowered Nightshade. A poisonous plant growing in the West India Islands. A cardiac poison not very unlike digitalis in effect. Dose of fl'ext.: 2 to 10 ♏ (0.13 to 0.6 Cc.).

ASCLEPIADEÆ.—Milkweed Family.

Herbs, usually milky-juiced, with opposite or whorled entire *leaves. Anthers* connected to the stigma and the pollen, cohering into waxy masses which hang in pairs from the glands of the stigma. The *juice* contains caoutchouc.

360. **ASCLEPIAS TUBEROSA.**—The root of **Ascle'pias tubero'sa** Linné. Off. in U. S. P. 1890. Enters the market in transverse or longitudinal sections about 20 mm. (⅘ in.) in thickness, and of various lengths; externally pale orange-brown or grayish, wrinkled longitudinally; internally it consists of a grayish or yellowish porous wood with broad, white medullary rays; fracture tough, uneven, showing the two distinct layers of the thin bark, the inner one white; odorless; taste bitter, somewhat acrid. Diaphoretic, expectorant. Dose: 15 to 60 gr. (1 to 4 Gm.). Fl'ext., off. U. S. P. 1890, dose, 15 to 60 ♏ (1 to 4 Cc.).

361. **ASCLEPIAS CORNUTI** Decaisne.—Common Silk-weed or Milk-weed. (Rhizome.) Cylindrical sections, from 6 to 25 mm. (¼ to 1 in.) thick, beset with a few simple rootlets; externally grayish-brown, finely wrinkled, and rough from stem-scars and undeveloped branches. It breaks with a short or splintery fracture, showing a thick bark containing lactiferous vessels, and a yellowish, porous wood in narrow wood-wedges. Odorless; taste bitter and nauseous. Diuretic, alterative, and expectorant; recommended in pectoral affections and in dropsy. Dose: 15 to 60 gr. (1 to 4 Gm.), in decoction.

362. **ASCLEPIAS INCARNATA** Linné.—Swamp Milk-weed. *Habitat:* North America. An oval or globular, yellowish-brown rhizome, with a tough, white wood, and a central pith; rootlets smooth, light yellowish-brown, brittle; odorless; taste sweetish, bitter, and acrid. It contains an emetic principle, **asclepiadin;** it is also alterative and cathartic. Dose: 15 to 45 gr. (1 to 3 Gm.).

363. **ASCLEPIAS CURASSAVICA** Linné.—Blood Flower. A West Indian herb used as an emetic, in smaller doses cathartic and vermifuge. Dose of fl'ext.: 1 to 2 fl. dr. (4 to 8 Cc.).

364. **HEMIDESMUS.**—Indian Sarsaparilla. The root of a climbing East Indian plant, **Hemides'mus in'dicus** R. Brown. Long, cylindrical, slender, and tortuous; externally wrinkled and fissured, dark brown; wood yellowish, separated from the thin bark by a dark, wavy cambium line. Odor sweetish, tonka-like; taste sweetish and acrid. It is used in India as an alterative, and also in Great Britain, where it is official. Dose: 30 to 60 gr. (2 to 4 Gm.), in infusion or decoction.

365. **CONDURANGO.**—The bark of **Gonolo'bus conduran'go** Triana, a South American vine, largely used there as an alterative. It was first introduced as a medicine here as a specific in cancer, but experience has shown it to be of no value in that trouble. It is from 2 to 6 mm. ($\frac{1}{12}$ to ¼ in.) thick, the outer surface or periderm ash-gray, with greenish or blackish lichen patches scattered over it; odor slight; taste bitter and acrid. It is given in doses of about 30 gr. (2 Gm.).

LOGANIACEÆ.—Logania Family.

Herbs, shrubs, or trees, with opposite, entire *leaves* connected by stipules or a stipular line, and with regular 4–5-merous, 4–5-androus *flowers*, the ovary free from the calyx. Many of the plants belonging to this order are extremely poisonous.

Synopsis of Drugs from the Loganiaceæ.

A. *Seeds.*
NUX VOMICA, 366.
Ignatia, 367.

B. *Bark.*
Hoang-nan, 368.

C. *Rhizomes.*
GELSEMIUM, 369.
SPIGELIA, 370.

D. *Extractive.*
Curara, 371.

366. NUX VOMICA.—Nux Vomica.

DOG BUTTON. QUAKER BUTTON. *Ger.* KRAHENAUGEN.

The dried ripe seed of **Strych'nos nux vom'ica** Linné yielding, by assay, not less than 1.25 per cent. of strychnine.

Botanical Characteristics.—A small tree with a crooked *stem* resembling a dogwood. *Leaves* short-petiolate, smooth, oval, mucronately, palmately, 3- to 5-nerved. *Flowers* small, greenish-white, in terminal corymbs ; *corolla* funnel-form. *Fruit* round, orange-like.

Source.—Indigenous to the coasts of most parts of India, Burmah, Siam, and northern parts of Australia. Large quantities of the drug are brought into the London market from British India. The export from Bombay is considerable. Madras and Calcutta are also shipping points.

Description of Drug.—**Orbicular disks** from 18 to 25 mm. ($\frac{3}{4}$ to 1 in.) in diameter, and about 4 mm. ($\frac{1}{6}$ in.) thick; flat or slightly convex on one side and concave on the other, with a slightly raised margin on the concave side. On one side is a ridge (raphe) extending from a raised point in the center (hilum) to a point on the edge where the radicle is situated (chalaza). Both surfaces have a **grayish or a grayish-green, shiny, silky appearance, due to a large number of silky hairs, closely pressed to the seed** and forming a tuft around its edge. Testa thin, fragile, somewhat soft, inclosing two disks of horny, translucent or opaque, yellowish or white albumen around a large central cavity. The embryo is contained in this cavity, and consists of a short radicle and two flat, heart-shaped, veined cotyledons extending about one-fourth the distance across it. Inodorous; taste extremely bitter. **Powdered nux vomica** is yellowish-gray and has a faint, sweetish odor. Should contain 1.25 per cent. of strychnine.

Powder.—Grayish-brown. Characteristic elements: Parenchyma of endosperm, very thick-walled with aleurone and oil globules, finely porous; color blue or violet with $K_2Cr_2O_7$ and H_2SO_4; trichomes, elongated, very thick-walled, lignified, colorless, with base wide and porous; starch, small amount in adhering proteid matter. In Ignatia bean, trichomes are rarely present.

FIG. 150.—*Strychnos nux vomica*—Flowering branch and seeds.

CONSTITUENTS.—The total alkaloids amount to 2.5 to 3.5 per cent. They consist principally of **strychnine,** $C_{21}N_{22}N_2O_2$, 1.25 per cent., and **brucine,** $C_{23}H_{26}N_2O_4$, the former being in excess. These are combined in the seed with igasuric acid. A third alkaloid, igasurine, has been claimed, but it is probably simply a mixture of the other two. A glucoside, loganin, $C_{25}H_{34}O_{14}$, has been found in the seeds, but it exists in greater quantity in the pulp surrounding the seed of the

fruit. Other constituents are a concrete fixed oil, gum, wax, phosphates, and a yellow coloring matter.

Strychnine.—As usually found in commerce, strychnine is a white or grayish-white powder. When rapidly crystallized from an alcoholic solution, it has the form of a white granular powder; when slowly crystallized, that of an elongated octahedra, or rhombic prisms with pyramidal capping. It is officially described as "in colorless, transparent, octahedral, or prismatic crystals," etc.

FIG. 151.—Cross-section of the fruit of *Strychnos nux vomica.*

Its solubilities and tests are given in the U. S. Pharmacopœia. The test usually employed for its recognition is sulphuric acid with potassium bichromate; gives a deep violet or blue color. Heated with strong nitric acid, yields picric acid.

Brucine.—Brucine occurs in rectangular octahedra containing $4H_2O$, readily soluble in alcohol; nitric acid colors blood-red, changing to orange and yellow, the yellow liquid becoming violet upon the addition of stannous chloride or ammonium or sodium sulphide.

Preparation of Strychnine.—Boil powdered seeds with acidulated (HCl or H_2SO_4) water. Decompose solution of alkaloidal salts by adding milk of lime, which precipitates strychnine and brucine. Wash precipitate; treat with dilute alcohol to dissolve brucine, or with alcohol or benzene to take out strychnine, thus leaving brucine in the residue. Purify with animal charcoal and reprecipitate with ammonia. Occurs in four-sided rhombic prisms; very bitter; soluble in boiling alcohol 5 parts chloroform, 110 alcohol.

ACTION AND USES.—Nux vomica is a tonic, spinal nervine, and a poison. In small doses it stimulates the appetite and digestion and the respiration. Dose: ½ to 5 gr. (0.0324 to 0.3 Gm.). Strychnine represents its action fully. Brucine has the same physiological action as strychnine, but is only about one-twelfth as strong.

OFFICIAL PREPARATIONS.

Fluidextractum Nucis Vomicæ, ... Dose:	½ to 5 ♏ (0.0324 to 0.3 Cc.).
Extractum Nucis Vomicæ, ...	½ to 1 gr. (0.0324 to 0.0650 Gm.).
Tinctura Nucis Vomicæ (2 per cent. of extract), ...	5 to 15 ♏ (0.3 to 1 Cc.).

STRYCHNINE AND ITS OFFICIAL PREPARATIONS.

Strychnina, ... Dose:	$\frac{1}{60}$ to $\frac{1}{20}$ gr. (0.001 to 0.003 Gm.).
Ferri et Strychninæ Citras, ...	1 to 5 gr. (0.065 to 0.3 Gm.).
Glyceritum Ferri, Quininæ, et Strychninæ Phosphatum (0.08 per cent.).	
Syrupus Ferri, Quininæ, et Strychninæ Phosphatum (25 per cent. of salt), ...	30 to 60 ♏ (2 to 4 Cc.).
Strychninæ Sulphas, ...	$\frac{1}{64}$ gr. (0.001 Gm.).

367. **IGNATIA.**—ST. IGNATIUS' BEAN. The seeds of **Strych'nos igna'tia** Lindley, a tree growing in the Philippine Islands, where they are much

esteemed as a medicine, and whence they were introduced to the medical world by the Jesuits, who conferred upon them the name of the founder of their order. The fruit is pear-shaped, and contains 10 to 15 of these **hard, heavy seeds** lying one upon the other and imbedded in a dry medullary mass, but the seeds come into market separate. Their shapes are various, owing to the manner in which they were situated in the fruit; but their general form is ovate, somewhat flattened, and more or less **angular.** They are about 25 mm. (1 in.) long, but considerably narrower, and have at one end a small depression indicating their point of attachment (hilum). Their testa is of a less silky nature than that of nux vomica, and of a gray-brown color. In commerce they are perfectly **smooth,** the testa and hairs being removed by the rubbing of the seeds against one another, and therefore the outer surface consists of **dull brown or blackish horny albumen,** translucent when fresh. The embryo is oblong, situated in the broad end of the seed, the cotyledons extending only about half the distance across the irregular cavity. Inodorous; taste excessively bitter.

CONSTITUENTS.—Same as nux vomica (366) but in different proportions, the strychnine existing to the extent of about 1.2 per cent. against $\frac{1}{3}$ to $\frac{1}{2}$ per cent. in nux vomica. Ignatia was once used for the preparation of this alkaloid, strychnine, but rarely at the present day, as nux vomica is imported in such large quantities and is a much cheaper source. Dose: $\frac{1}{2}$ to 5 gr. (0.0324 to 0.3 Gm.).

368. **HOANG-NAN or HOANG-NAO.**—TROPICAL BINDWEED. The bark of **Strych'nos malaccen'sis** Bentham, a creeping vine growing in the mountains of Tonquin. This bark is in general use among the natives of Tonquin, Cochin-China, Venezuela, etc., as a remedy in leprosy and hydrophobia, and as an antisyphilitic and alterative. First brought to the notice of the medical profession by the missionary fathers. It contains strychnine and brucine in about equal proportions, and probably has about the same range in medicine as nux vomica. Dose: $\frac{1}{2}$ to 5 gr. (0.0324 to 0.3 Gm.).

369. GELSEMIUM.—GELSEMIUM.

YELLOW JASMINE. *Ger.* GIFTJASMIN.

The dried rhizome and roots of **Gelse'mium sempervir'ens** Aiton.

BOTANICAL CHARACTERISTICS.—*Stem* smooth, climbing. *Leaves* short-petiolate, shining, ovate. *Flowers* in short axillary clusters, very fragrant; *corolla* bright yellow, funnel-form, 5-lobed.

HABITAT.—Southern United States, notably Florida.

DESCRIPTION OF DRUG.—Generally in very light and fibrous cylindrical sections, 90 to 200 mm. long, 4 to 15 mm. in diameter; externally of a brownish-yellow color, slightly wrinkled; tough, breaking with a fibrous, splintery fracture; bark thin, with silky bast fibers, adhering to the light-yellowish, porous, broadly-rayed wood; the wood-cells are more or less indurated and free of starch-grains; medullary rays contain few starch-granules; pith small; odor characteristic; taste persistently bitter.

ADULTERATION.—Mixed with the true gelsemium there are sometimes found the roots of the jessamine or jasmine; as an adulterant this has become known as false gelsemium. The true yellow jasmine (*Jasminum fructicans* Linné) is called *Gelsemium officinale* in Europe.

In cross-section the false root, according to Dohme, has no indurated cells in the medulla. Its medullary rays are full of starch-grains, and the sieve-ducts at the outer end of the woody cylinder are, in the case of every woody wedge, surrounded and protected by several rows of bast fibers. The true gelsemium has no such bast fibers.

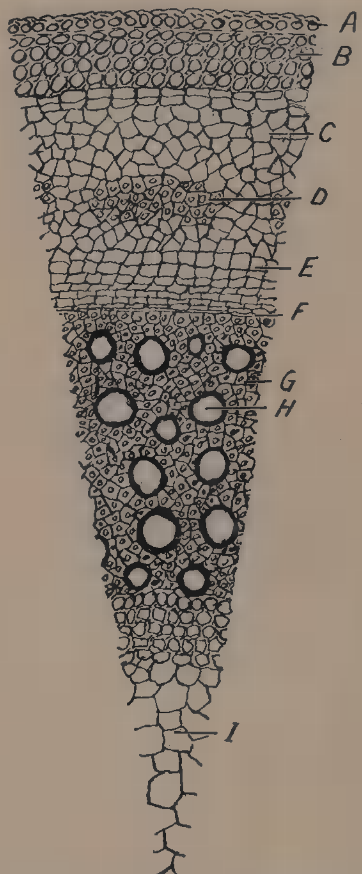


FIG. 152.—Cross-section of the stem of Gelsemium. *A*, Epidermis. *B*, Collenchyma. *C*, Parenchyma of cortex. *D*, Bundles of sclerenchymatous cells. *E*, Sieve tissue. *F*, Cambium. *G*, Wood fibers. *H*, Tracheal tubes. *I*, Pith cells.

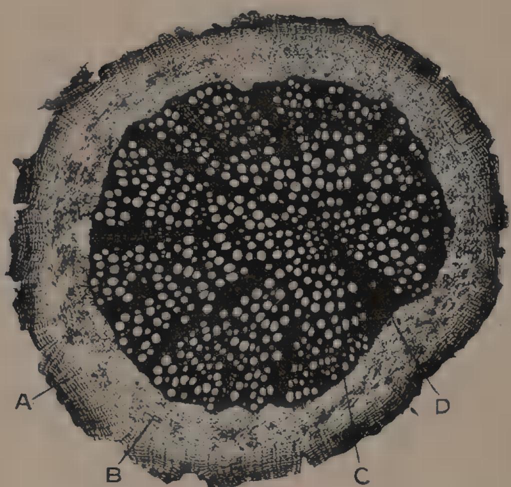


FIG. 153.—Gelsemium—Cross-section of root. (19 diam.) A, Cork. B, Phloëm. C, Xylem. D, Medullary ray. (Photomicrograph.)

Accidental admixture of stems may be detected by the latter having bundles of bast fibers near the cortex. In the rhizome the fibers are not in bundles, but in a more or less interrupted ring.

Powder.—Light brown. Parenchyma of cortex, with starch (4 to 8 μ in diam.), calcium oxalate in prisms (15 to 30 μ in diam.); sclerenchyma with stone cells about 50 μ in diam.; bast fibers, long, narrow; ducts, large with straight pores (20 to 60 μ in diam.); considerable cork.

CONSTITUENTS.—**Gelsemine,** $C_{54}H_{69}N_4O_{12}$, gelseminine, gelseminic acid, volatile oil, resins, gallic acid, etc. Gelsemine is a brittle, white,

transparent solid, soluble in alcohol, from which it crystallizes with difficulty. The root yields from 0.3 to 0.5 per cent. of alkaloid.

Preparation of Gelsemine.—Add acetic acid to concentrated tincture; precipitate resin with water; concentrate the aqueous filtrate; remove gelsemic acid with chloroform or ether. The acid liquid yields impure alkaloid when precipitated by Na_2CO_3. This is purified by solution in chloroform and slow evaporation. It is a white, amorphous, very bitter alkaline alkaloid; with HCl or HNO_3 forms crystalline salts.

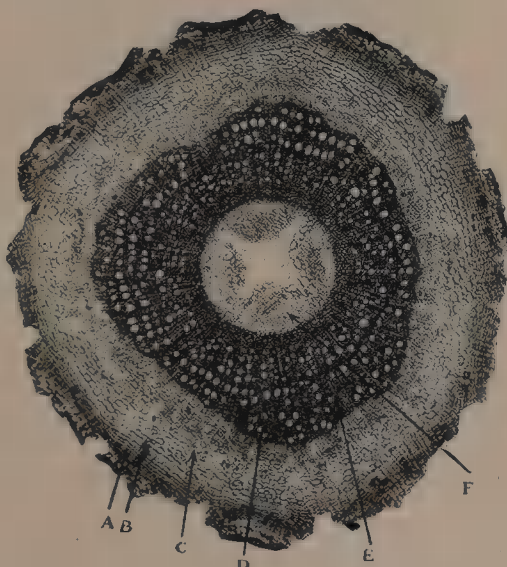


FIG. 154.—Gelsemium—Cross-section of rhizome. (25 diam.) A, Cork. B, Parenchyma of cortex. C, Bast fibers. D, Xylem. E, Medullary ray. F, Medulla. (Photomicrograph.)

ACTION AND USES.—**Antispasmodic, sedative,** and diaphoretic. Dose: 2 to 10 gr. (0.13 to 0.6 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Gelsemii, ...Dose: 2 to 10 ♍ (0.13 to 0.6 Cc.).
Tinctura Gelsemii (10 per cent.), ... 2 to 15 ♍ (0.13 to 1 Cc.).

370. SPIGELIA.—SPIGELIA.

PINK ROOT. CAROLINA PINK. *Ger.* MARYLANDISCHE SPIGELIE.

The dried rhizome and roots of **Spige'lia marilan'dica** Linné.

BOTANICAL CHARACTERISTICS.—*Root* perennial; *stem* simple and erect. *Leaves* sessile, ovate-lanceolate, acute. *Flowers* in a short spike; *corolla* red externally, yellow within, four times the length of the calyx; *stamens* and *pistil* exserted.

HABITAT.—United States, Maryland southward and westward in rich woods.

DESCRIPTION OF DRUG.—Rhizome **thin, bent, purplish-brown,** on the upper side marked with stem scars, on the lower side beset with

numerous lighter colored, slender, branching rootlets. It has a **dark or decayed pith.** Fracture short. Odor slight, aromatic; taste sweetish, bitter, and pungent.

RELATED SPECIES.—Another species which has attracted attention as an

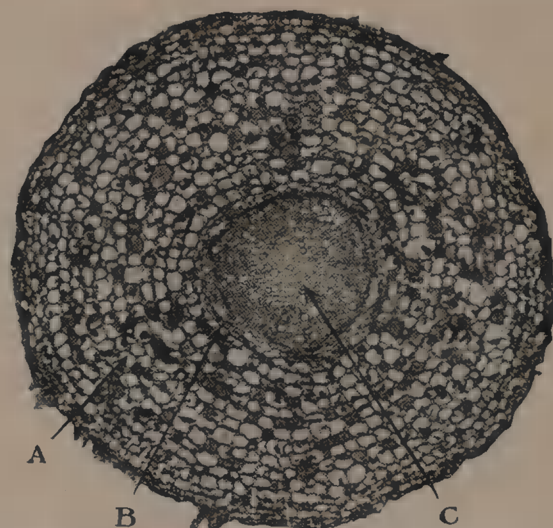


FIG. 155.—Spigelia—Cross-section of rootlets. (37 diam.) A, Parenchyma of cortex. B, Medulla. C, Xylem. (Photomicrograph.)

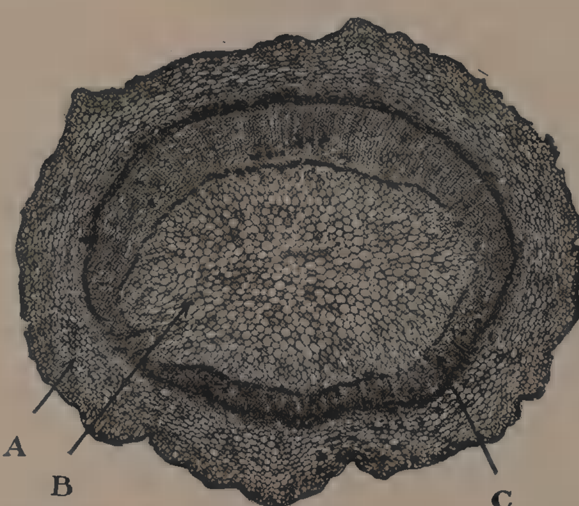


FIG. 156.—Spigelia—Cross-section of rhizome. (21 diam.) A, Parenchyma of cortex. B, Medulla. C, Xylem. (Photomicrograph.)

anthelmintic is *Spigelia anthelmia* of South America and the West Indies, which in that country is said to have greater medicinal properties than the official.

Powder.—Pale brown. Characteristic elements: Parenchyma of cortex with cells elongated, outer cells with cystoliths; other cells with spherical starch grains 4 μ in diam. and resinous brown coloring-matter; sclerenchyma with stone

cells which are bast-like, large, and finely porous, 20 to 40 μ thick, 200 to 300 μ long; ducts with simple pores; cork, small amount, dark purplish-brown.

CONSTITUENTS.—A volatile alkaloid, **spigeline,** is the active principle.

Preparation of Spigeline.—Distil the powdered drug over a paraffin bath with milk of lime; collect the distillate in HCl and evaporate to dryness; crystallize from alcoholic solution.

ACTION AND USES.—A **powerful anthelmintic.** Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Spigeliæ, ...Dose: 15 to 60 ♏ (1 to 4 Cc.).

371. **CURARA.**—CURARE. WOORARI. From **Strych'nos castelnæa'na** and other species of Strychnos growing in South America, where an extract is prepared by the natives as an arrow-poison. This extract is a blackish, friable solid or of extract-like consistence, having a somewhat resinous appearance, and very hygroscopic. It contains a very bitter and poisonous alkaloid, curarine. As a remedial agent curara has probably little value, although it has been used in tetanus, hydrophobia, epilepsy, and chorea. It is a strong depressant of the motor nerves, causing a gradual loss of muscular power, deepened respiration, and death by asphyxia. Dose: $\frac{1}{10}$ to $\frac{1}{3}$ gr. (0.006 to 0.02 Gm.).

Curarine ($C_{18}H_{35}N$).—From the drug Roulin obtained this principle by a very intricate process. The alkaloid is extremely deliquescent and crystallizes in prisms, soluble in water, and changes litmus feebly.

GENTIANEÆ.—Gentian Family.

Smooth herbs with a colorless, bitter juice, and containing little or no tannin.

Synopsis of Drugs from the Gentianeæ.

A. *Roots.*
GENTIANA, 372.
Frasera, 373.

B. *Herbs.*
CHIRATA, 374.
Sabbatia, 375.
Menyanthes, 376.

372. GENTIANA.—GENTIAN.

GENTIAN. *Ger.* ENZIANWURZEL.

The dry rhizome and roots of **Gentia'na lu'tea** Linné.

BOTANICAL CHARACTERISTICS.—Root perennial, large; stem 2 to 3 feet high. *Leaves* opposite, sessile, 5- to 7-nerved, ovate-acute, more or less clasping. *Flowers* in whorls, bright yellow; *corolla* with 5 or 6 green glands at its base; *stigmas* 2.

HABITAT.—Mountainous portions of Central Europe.

DESCRIPTION OF DRUG.—Cylindrical, fleshy, and very long, often 3 feet or more; it is generally cut longitudinally about 100 to 200 mm. (4 to 8 in.) long, and 5 to 40 mm. ($\frac{1}{5}$ to $1\frac{3}{5}$ in.) thick; in drying, these slices are depressed in the center and the bark overlaps; **yellowish-**

brown, much wrinkled longitudinally and marked transversely, especially in the upper portion, with numerous rings. Transversely the bark is rather thick, wrinkled, and contorted, separated by a black cambium line from the yellowish-brown, porous, and spongy meditullium marked with indistinct medullary rays. Fracture irregular, brittle when dry, flexible and tough when damp; odor pro-

FIG. 157.—*Gentiana lutea*—Flowering head and dissected flower.

nounced and characteristic; **taste** intensely bitter, sweetish, and not disagreeable.

Gentiana catesbæi, the blue gentian of the Southern States, growing in mossy swamps, is said to be little inferior to the official species. It is sometimes used to adulterate senega. Other indigenous species, as *G. purpurea* and *G. punctata*, have about the same proper-

ties as the official gentian and are used similarly. The herb *G. quinqueflora* is used in liver affections, chronic ague, jaundice, etc.

FIG. 158.—Gentian—A, Rhizome portion. B, Root portion. (½ natural size.)

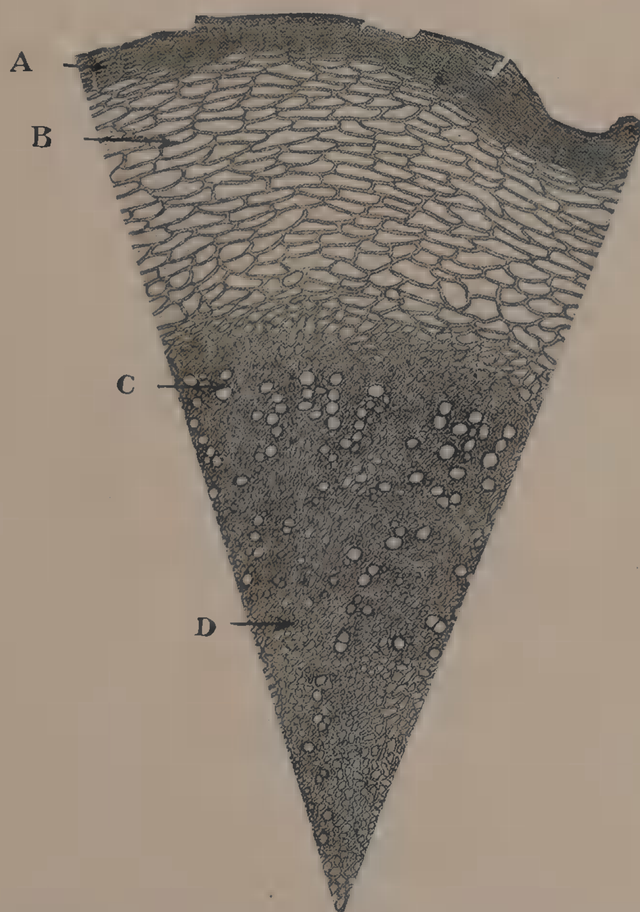


FIG. 159.—*Gentiana lutea*—Cross-section. A, Cork. B, Parenchyma of cortex. C, Water tube. D, Parenchyma of xylem.

Powder.—Orange brown. Characteristic elements: Parenchyma cells, large and empty, usually collapsed; ducts, few, large (30 to 60 μ in diam.); cork, brownish (25 to 35 μ in diam.); collenchyma, thick-walled, lies just inside of cork; wood fibers, usually not lignified; calcium sulphate forms in needles with H_2SO_4.

CONSTITUENTS.—The bitter principle is a neutral principle, **gentiopicrin,** $C_{20}H_{30}O_{12}$, the yellow color is due to **gentisin,** $C_{14}H_{10}O_5$, or **gentisic acid** (tasteless yellow prisms). The root also contains from 12 to 15 per cent. of glucose (gentianose), $C_{16}H_{66}O_{31}$, but is remarkable in that it contains **no starch, calcium oxalate,** or **tannin.**

Preparation of Gentisic Acid.—The alcoholic extract is washed with water, then with ether. The residue dissolved in alcohol yields the acid on evaporation. It is in yellow, tasteless crystals, partially soluble in alcohol and ether; with ferric salts gives dark brown color.

Preparation of Gentiopicrin.—Obtained by making aqueous solution of alcoholic extract. This solution is subjected to the absorptive action of charcoal. Charcoal is then boiled with alcohol, tincture evaporated, and treated with lead oxide to remove color. Lead removed by H_2S; solution agitated with ether. Set solution aside to crystallize. Yellowish-brown, soluble in water and dilute alcohol.

ACTION AND USES.—**Simple bitter tonic,** long known and very valuable. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Gentianæ, ...Dose:	5 to 30 ♏ (0.3 to 2 Cc.).
Extractum Gentianæ, ...	5 to 10 gr. (0.3 to 0.6 Gm.).
Tinctura Gentianæ Composita (10 per cent., with orange-peel and cardamom),	1 to 2 fl. dr. (4 to 8 Cc.).

373. **FRASERA.**—AMERICAN COLUMBO. The root of **Fra'sera wal'teri** Michaux, a plant growing extensively in Southern and Western United States, especially in Arkansas and Missouri. Its root is long and spindle-shaped, but comes into market in transverse slices, irregularly circular, about 25 mm. (1 in.) in diameter; these disks consist of a central medullary matter, yellowish-brown, shrunken in the middle, and a reddish-brown exterior; inodorous; taste at first sweet, then bitter. It may be distinguished from columbo by its greater uniformity of internal structure, the absence of concentric and radiating lines, and its purer yellow color without the green tinge. It occasionally comes into the market in longitudinal slices under the name of American gentian. It contains gentiopicrin and gentisic acid, but no starch or tannin. Simple bitter tonic like columbo and gentian. Dose: 15 to 30 gr. (1 to 2 Gm.).

374. CHIRATA.—CHIRATA.

CHIRETTA. *Ger.* OSTINDISCHER ENZIAN.

The dried plant **Swer'tia chira'yita** Hamilton.

BOTANICAL CHARACTERISTICS.—An annual plant, 2 to 3 feet high. *Leaves* opposite, clasping, lanceolate-acute, 5- to 7-nerved. *Flowers* petiolate, in umbel-like cymes; *corolla* persistent, yellow, rotate; *style* single, stigma 2-lobed.

HABITAT.—Nepaul and other parts of Northern India.

DESCRIPTION OF DRUG.—Chirata of the market consists principally of **short sections** of the stem and branches, **orange-brown** or **dark purple** in color, **generally pressed and split,** showing the yellow pith, and mixed with a few leaves and flower panicles. These stems

when entire are about 4 mm. ($\frac{1}{6}$ in.) in thickness, round at base and quadrangular toward the top, jointed, the internodes being from 37 to 100 mm. ($1\frac{1}{2}$ to 4 in.) in length; branches opposite. Inodorous when dry, but when moistened it has a perceptible odor; taste very bitter, persistent.

In the Indian bazaars there are a number of species of Ophelia, known by the name of *Chiretta*, which possess, to a greater or less degree, the bitter properties of that drug. Flückiger states: "We have frequently examined the chiretta found in the English market, but have never met with any other than the legitimate sort." Bentley noticed, in 1874, the substitution of *O. angustifolia*, which he found by far to be less bitter than the true chiretta. J. S. Ward ("Pharm. Jour.," 4th Series, 1, 1897) calls attention to a false chirata entering the market recently. He recognized it as the product of *Andrographia paniculata*, nat. ord. Acanthraceæ, a plant distributed throughout India from Lucknow and Assam to Ceylon, and cultivated in the West Indies—a domestic remedy for fevers, debility, etc. Sold by herbalists in the fresh state.

Powder.—Grayish-brown. Characteristic elements: Parenchyma of medulla, slightly lignified with simple pores; sclerenchyma with fibers, long, narrow, and thick-walled; tracheids, numerous; ducts with spiral or scalariform markings; yellowish-brown pollen and stomata present.

CONSTITUENTS.—**Chiratin,** $C_{26}H_{48}O_{15}$ (yellow, hygroscopic powder, very bitter), **ophelic acid,** $C_{13}H_{20}O_{10}$ (a syrupy liquid, very bitter), resin, coloring matter, bitter extractive, gum, and salts. Water and alcohol extract its virtues.

ACTION AND USES.—**Bitter tonic** like the other plants of the order Gentianeæ. Dose: 15 gr. (1 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Chiratæ (10 per cent.) (1890), Dose:	$\frac{1}{2}$ to 2 fl. dr. (2 to 8 Cc.).
Extractum Chiratæ Fluidum, ...	30 to 60 ♏ (2 to 4 Cc.).

375. **SABBATIA.**—CENTAURY. Three species of this indigenous herb are more or less used in this country as tonic and antiperiodic. These are *Sabba'tia angular'is* Pursh (American centaury), *S. paniculata* Pursh, and *S. Ellio'tti* Steudel (quinine flower); the whole plant of the two first-named species is used, the root of the last-named; they probably all contain the same principle, erythrocentaurin, $C_{27}H_{24}O_8$. Dose: about 1 dr. (4 Gm.).

376. **MENYANTHES.**—WATER SHAMROCK. BUCKBEAN. The herb of **Menyan'thes trifolia'ta** Linné, an aquatic plant growing in bogs in the temperate zone of the Northern Hemisphere. Leaves ternate, rising out of the water on long petioles from a rhizome; leaflets obovate, about 50 mm. (2 in.) long, with entire margin, and smooth, green upper surface, paler beneath. It has no odor, but a very bitter taste, due to a bitter principle, menyanthin, $C_{33}H_{54}O_{16}$ (?). Bitter tonic, in large doses cathartic. Employed in the preparation: **Vinum Aurantii Compositum** N. F. (*Elix. Aurantiorum Compositum*, Germ. Pharm.). Dose: 15 to 45 gr. (1 to 3 Gm.).

HYDROPHYLLACEÆ.—Waterleaf Family.

377. ERIODICTYON.—Eriodictyon.

YERBA SANTA. MOUNTAIN BALM. CONSUMPTIVE'S WEED.

The dried leaves of **Eriodic'tyon Californicum** Greene.

Botanical Characteristics.—Low shrubs with alternate *leaves*. *Calyx* of narrow sepals; *corolla* violet or purple, occasionally white, with the filaments adherent to it; *ovary* 2-celled. *Fruit* a small capsule.

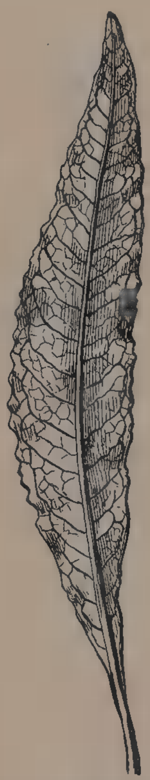


Fig. 160.—Leaf of Yerba Santa. Under side.

Habitat.—California, and in mountains of Northern Mexico.

Description of Drug.—Oblong-lanceolate, from 50 to 100 mm. (2 to 4 in.) long, 10 to 30 mm. ($\frac{2}{5}$ to $1\frac{1}{5}$ in.) broad, with a sharp apex, and narrowed at the base into a short foot-stalk; margin sinuate or almost entire; upper surface brownish-green and **varnished with a resinous coating; under surface greenish-white, hairy,** with a prominent midrib and **distinct reticulations;** brittle, odor aromatic; taste balsamic, sweetish, free from bitterness.

Related Species.—*Eriodictyon tomentosum*, growing with the other, is large and has a dense coat of short, villous hairs, becoming whitish or musty-colored with age.

Powder.—Dull green. Characteristic elements: The peculiar epidermal cells; numerous, elongated, wavy trichomes and crystals of calcium oxalate, constitute the interesting microscopical features for study.

Constituents.—Volatile oil, an acrid resin, tannin, ericolin, $C_{34}H_{56}O_{21}$.

Action and Uses.—Long used in California as a stimulant balsamic expectorant. Its preparations are principally used, however, as **vehicles** to disguise the taste of disagreeable medicines like quinine. Dose: 15 to 30 gr. (1 to 2 Gm.).

Official Preparation.

Fluidextractum Eriodictyi, ... Dose: 15 to 30 ♍ (1 to 2 Cc.).

POLEMONIACEÆ.—Polemonium Family.

378. **POLEMONIUM REPTANS** Linné.—Abscess Root. The root of this American plant has been used as an alterative, astringent, diaphoretic, and expectorant. Dose: 30 to 60 gr. (2 to 4 Gm.).

BORRAGINACEÆ.—Borage Family.

379. **ALKANNA.**—ALKANET. The root of **Alkan'na tincto'ria** Tausch. *Habitat:* Grecian Archipelago and Southern Europe. Fusiform, about 100 mm. (4 in.) long, from the thickness of a quill to that of the little finger, often crowned with soft, white, hairy root-stocks; the bark is of a dark-purple color, friable, and separates easily in thin, papery layers from the yellowish, twisted ligneous column; the wood is composed of distinct, slender wood-fibers cohering together and cleft by purple, friable, medullary rays; in the commercial samples, however, it is generally more or less decayed, loose, and spongy. Odorless and tasteless. Alkanna is employed exclusively for coloring oils, ointments, and plasters, which is accomplished by suspending it, tied up in a rag, into the melted fat. Its coloring principle has been termed alkannin; it is a red, resin-like substance, soluble in alcohol, ether, and fats, but insoluble in water.

Preparation of Alkannin.—Obtained by evaporation of ethereal tincture, or precipitating a weak alkaline aqueous solution of alkanet by an acid.

380. **SYMPHYTUM.**—COMFREY. The root of **Sym'phytum officina'le** Linné. *Habitat:* United States and Europe; cultivated. About 150 mm. (6 in.) or more long, and from the thickness of a quill up to an inch in diameter, often split; externally black, wrinkled; internally whitish, and horny when dry; inodorous; taste sweetish, astringent, and very mucilaginous, containing as much mucilage as, or more than, althæa, for which it may often be substituted. It is chiefly used as a demulcent in domestic cough remedies, and has been highly esteemed as a vulnerary. Dose: 2 to 4 dr. (8 to 15 Gm.).

381. **BORAGO OFFICINALIS** Linné.—BORAGE. *Habitat:* Europe. (Leaves.) They contain a large quantity of mucilage, with potassium nitrate and other salts, upon which their virtues depend. Diuretic, refrigerant, demulcent, etc. Dose of fluidextract: 1 fl. dr. (4 Cc.).

382. **PULMONARIA OFFICINALIS** Linné.—LUNGWORT. *Habitat:* Europe. (Leaves.) Pectoral and demulcent. Dose: 30 to 60 gr. (2 to 4 Gm.).

CONVOLVULACEÆ.—Convolvulus Family.

Chiefly twining or trailing herbs, sometimes with milky juice, with alternate *leaves*, and regular, 5-androus *flowers*.

Tuber.	*Resin.*
JALAPA, 383.	**SCAMMONIUM,** 385.
Root.	
Ipomœa, 384.	

383. JALAPA.—JALAPA.

JALAPA. *Ger.* JALAPENWURZEL.

The dried tuberous root of **Exogo'nium pur'ga** (Wenderoth) Bentham, yielding, by assay, not less than 8 per cent. of resin. (See Constituents.)

BOTANICAL CHARACTERISTICS.—*Stem* brownish, smooth. *Leaves* long-petiolate, cordate-ovate, acuminate, entire, smooth. *Peduncles* axillary, 2-flowered; *corolla* crimson or light red, four times the length of the calyx.

HABITAT.—Mexico; now successfully cultivated in India.

DESCRIPTION OF DRUG.—**A compact, heavy, hard, pear-shaped tuber,** varying in size, but never larger than the fist; the larger ones are longitudinally incised to facilitate the drying, which is done over the hearths of the Indian huts, hence **externally** brown, smoky, more or less wrinkled, covered with thick, round warts of a somewhat lighter color; **internally** gray to dark brown; fracture horny and resinous; odor peculiar, smoky, partly due to the manner of drying; taste starchy, afterward slightly acrid. **Powdered jalap** is yellowish-gray, and when inhaled causes sneezing and coughing.

STRUCTURE.—Cortical layer thin, with a dense circle of resin cells near the cambium line; interior composed chiefly of parenchymatous

FIG. 161.—Jalap tuber. (Photograph.)

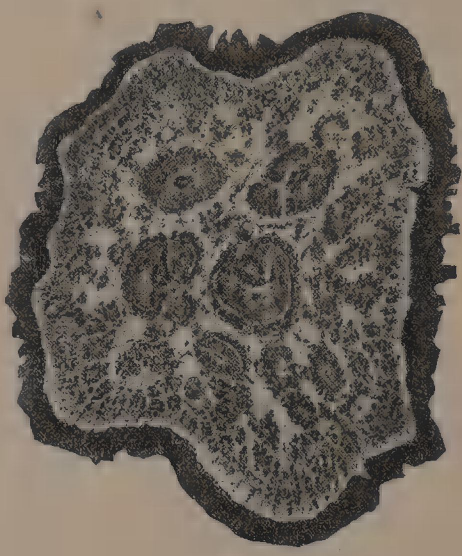


FIG. 162.—Jalap—Cross-section of tuber. (2 diam.) (Photograph.)

tissue containing starch and calcium oxalate, arranged in which are concentric zones of resin cells, the broader, darker, alternate zones being formed by a closer packing of the cells; medullary rays small, but plainly visible. The false jalaps which frequently adulterate the drug in market may usually be detected by the difference in internal structure.

ADULTERATIONS.—Immature roots, roots partially deprived of resin by treatment with alcohol. These are sticky, internally darker than the genuine and other species of Ipomœa.

Powder.—Grayish-brown. Characteristic elements: Outer parenchyma of cortex with aggregate crystals of calcium oxalate; starch, single and 1 to 3 compound, granules average (20 to 25 μ in diam.), sometimes swollen or pasty; ducts, large and small, porous; tracheids few; secretion cells, yellowish-brown;

laticiferous ducts, large, with transverse walls; reddish cork, considerable. (See starch grains highly magnified, Fig. 367.)

CONSTITUENTS.—Besides starch, calcium oxalate, etc., jalap contains a resinous substance which consists of two portions, a soft resin, **jalapin,** soluble in ether, and a hard resin, constituting nine-tenths of the mixture, termed **jalapurgin or convolvulin** (a glucoside, $C_{31}H_{50}O_{16}$); this latter is supposed to be the active principle. The U. S. Pharmacopœia has fixed the lowest limit of resin at 8 per cent. Jalap should not contain more than 1.5 per cent. of **ether-soluble** resin.

The varying strength in jalap may be accounted for by the fact that the roots are dug at all seasons of the year. In the fall, when the aërial stem has decayed, it is better than in the spring, at the sprouting season.

ACTION AND USES.—**Hydragogue cathartic,** generally used in dropsy in the compound powder of jalap. Dose: 15 to 30 gr. (1 to 2 Gm.).

OFFICIAL PREPARATIONS.

Pulvis Jalapæ Compositus (35 per cent., with potassium bitartrate), ... Dose:	15 to 60 gr. (1 to 4 Gm.).
Resina Jalapæ, ...	2 to 5 gr. (0.13 to 0.3 Gm.).
Pilulæ Catharticæ Compositæ, ...	2 to 5 pills.
Pilulæ Catharticæ Vegetabiles, ...	2 to 5 pills.
Extractum Jalapæ (U. S. P. 1890), ...	2 to 5 gr. (0.13 to 0.3 Gm.).

384 a. **IPOMŒA PANDURATA.**—WILD JALAP. MAN-ROOT. MAN OF THE EARTH. The root of **Ipomœ'a pandura'ta** Meyer. Occasionally met with in commerce, in the form of longitudinal slices with an irregularly wrinkled, brownish-gray bark overlapping the white wood. The woody center is divided into narrow wood-wedges by medullary rays dotted with resin cells. Nearly inodorous; taste sweetish and bitter. Contains panaquilon (the sweet principle found in panax), mucilage, starch, resin, etc. Diuretic and cathartic. Dose: 15 to 60 gr. (1 to 4 Gm.).

384 b. **FALSE JALAPS.**—*Ipomœa simulans* (Tampico jalap), a somewhat globular root yielding a resin (tampicin), very similar to jalapin, nearly soluble in ether. *I. orizabensis* (fusiform or male jalap), a spindle-shaped, large, woody root, often in sections, the resin orizabin (unfortunately named jalapin) entirely soluble in ether.

385. SCAMMONIUM.—SCAMMONY.

SCAMMONY. *Ger.* SCAMMONIUM.

A gum resin obtained by incising the living root of **Convol'vulus scammo'nia** Linné.

BOTANICAL CHARACTERISTICS.—*Root* perennial, tapering, 3 to 4 feet long, from 9 to 12 in. in circumference at the crown, and abounding in a milky, acrid juice. *Stem* annual, smooth. *Leaves* petiolate, sagittate, entire. *Peduncles* cymose, 3-flowered, twice the length of the leaves; *calyx-lobes* with a reflexed point; *corolla* pale yellow. *Capsule* 2-celled, 4-seeded.

HABITAT.—Western Asia. Obtained like asafœtida.

DESCRIPTION OF DRUG.—The pure, or, as it is called, the "genuine"

scammony is scarce in the market, the ordinary article being impure from flour, chalk, ashes, sand, etc., mixed with the exuded milk-juice before it has entirely hardened. It usually comes in hemispherical cakes, convex on one side, about 100 to 150 mm. (4 to 6 in.) in diameter; externally dark gray or nearly black; fracture brittle, shining, somewhat rough, exhibiting a usually porous interior, lighter colored and tinged with yellow or green. It yields a **light-gray powder**

FIG. 163.—*Convolvulus scammonia*—Branch.

having a peculiar **odor resembling cheese or putty**; taste slight, but leaves an acrid sensation in the throat

CONSTITUENTS.—Gum, resin, starch, **scammonin,** $C_{34}H_{56}O_{16}$, etc. Not less than 75 per cent. of the drug should be soluble in ether; ash not more than 3 per cent.

ACTION AND USES.—**Hydragogue cathartic,** on account of its harshness, generally given in combination. Uncertain on account of

frequent impurities. Dose: 1 to 8 gr. (0.065 to 0.5 Gm.), in emulsion.

OFFICIAL PREPARATION.

Resina Scammonii, ...Dose: 1 to 8 gr. (0.065 to 0.5 Gm.).

SOLANACEÆ.—Nightshade Family.

Herbs or, rarely, shrubs, with rank-scented, often poisonous, foliage, and colorless juice. *Leaves* alternate. *Stamens* five, equal, inserted on the corolla. *Fruit* a capsule or berry. This order owes its poisonous qualities to the presence of alkaloids such as atropine.

Synopsis of Drugs from the Solanaceæ.

A. *Roots.*
- **BELLADONNÆ RADIX,** 386.
- Manaca, 388.

B. *Leaves.*
- **BELLADONNÆ FOLIA,** 387.
- **STRAMONII FOLIA,** 389.
- **HYOSCYAMUS,** 391.
- Tabacum, 393.
- Duboisia, 394.

C. *Stems and Branches.*
- Pichi, 395.

D. *Seeds.*
- Stramonii Semen, 390.
- Hyoscyami Semen, 392

E. *Branches.*
- Dulcamara, 396.

F. *Fruits.*
- **CAPSICUM,** 398.
- Lycopersicum, 399.

G. *Herb.*
- Solanum Carolinense, 397.

BELLADONNA.—DEADLY NIGHTSHADE.

The dried root and the dried leaves official.

BOTANICAL CHARACTERISTICS.—**At'ropa Belladon'na** Linné. *Root* perennial, fleshy, white within; *stem* 3 to 5 feet high, with a tinge of red. *Leaves* short-petiolate, ovate, acute, entire, more or less hirsute. *Flowers* solitary, drooping; *calyx* campanulate; *corolla* campanulate, twice the length of the calyx, greenish at the base, varying to dark purple at the border. *Berry* 9-lobed, violet-black; seeds uniform.

SOURCE AND COLLECTION.—Central and Southern Europe; in a few localities in England, Germany, France, as well as in North America, the plant is cultivated for medicinal use.

The roots should be collected from plants of three or more years' growth, and preferably in the spring. A. Kremel ("Chemist and Druggist," 1897–'98, p. 48) found that the root gathered in June and October from the same spot yielded from the first 0.88 per cent. of alkaloid and 26.6 per cent. of solid extract, the October root 0.225 per cent. of alkaloid and 16.6 per cent. of extract.

386. BELLADONNÆ RADIX.

Ger. WOLFSKIRCHEN-WURZEL.

The dried root of **Atropa Belladonna** Linné, yielding, when assayed by U. S. P. process, not less than 0.5 per cent. of its alkaloids.

DESCRIPTION OF DRUG.—Rough, irregular, longitudinally wrinkled,

somewhat tapering pieces, from 12 to 25 mm. ($\frac{1}{2}$ to 1 in.) thick, **of a dirty-gray color externally, internally whitish**; fracture short, mealy when dry, tough when damp; odor narcotic; **taste** slightly sweetish, afterward bitter and acrid. Tough, woody roots, breaking with a splintery fracture, should be rejected, also the hollow

Fig. 164.—*Atropa belladonna*—Branch.

stem-bases sometimes present. The root should yield when assayed by the U. S. P. process not less than 0.5 per cent. of total alkaloids.

Structure.—The bark is rather thick, free from bast fibers, composed almost entirely of parenchymatous tissue containing starch-grains and calcium oxalate raphides; directly underneath the periderm is a darker line composed of six to eight tabular cells. In the center of the root is a small pith, surrounded in the younger root by distant wood-fibers scattered throughout the parenchymatous tissue; in older

roots the wood-bundles are more numerous, and traversed by broad medullary rays.

Belladonna is sometimes mistaken for, or adulterated with, althæa, from which it may be distinguished by the smoothness of its outer layer (althæa has projecting fibers), by its fracture, which does not show protruding fiber-ends, and by the wood-bundles, which are readily discernible in the former, but not in the latter.

ADULTERATIONS.—Certain species of Mandragora yield very nearly

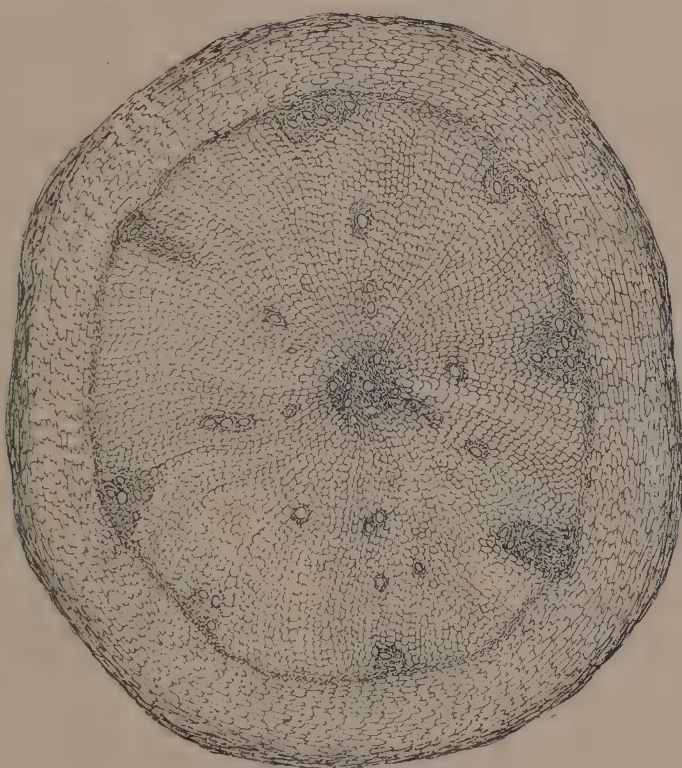


FIG. 165.—Cross-section of Belladonna root.

allied roots both in external appearance and structure, but they are not likely to be confounded with belladonna roots.

Attention has been called to species of Scopola, a genus connecting atropa and hyoscyamus, as resembling belladonna. The rhizomes of the *S. carniolica* are very similar to the root of belladonna; the bark, however, of the former, is less thick, starch-grains smaller, and shape less distinct. *Scopola Japonica* (Japanese belladonna) was found to be similar to *S. carniolica*. This drug is now official. See Scopola.

Powder.—Brownish-gray. Characteristic elements: Parenchyma of cortex with starch (5 to 15 μ in diam.), spherical, simple or 2 to 3 compound, and

crystal sand of calcium oxalate; sclerenchyma from rhizome, with bast fibers; ducts, few and large, scalariform or reticulate, spiral with simple pores; tracheids few, from old roots; cork small amount; Scopola is similar, but has smaller starch granules, with other histological elements that require close study to distinguish.

CONSTITUENTS.—**Atropine,** $C_{17}H_{23}NO_3$ (0.2 to 0.6 per cent.), **belladonnine,** $C_{17}H_{23}NO_4$, **hyoscyamine,** $C_{17}H_{23}NO_3$, atropamine (sometimes present), and atrosine (fluorescent). Atropine is in white, acicular crystals or white, amorphous powder, with a strong alkaline reaction; it exists in the root as a malate and is now known to be an isomer of hyosciamine. The latter alkaloid by the action of the heat and alkali during many of the processes of extraction, precipitation, etc., becomes converted into its isomer, atropine.

Preparation of Atropine.—Obtained by first removing resin in alcoholic tincture of root, acidifying with H_2SO_4. Evaporate filtrate and carefully neutralize the concentrated liquid with K_2CO_3. Filter to remove more resin; to filtrate add K_2CO_3 in excess. Collect resulting precipitate. Dissolve in chloroform. Decolorize by animal charcoal. Distil off chloroform and crystallize residue from its alcoholic solution.

Solanaceous Alkaloids.—The researches of Ladenburg prove that the three mydriatic alkaloids, atropine, hyoscyamine, and hyoscine, are contained as follows: Atropine in *Atropa Belladonna* and *Datura stramonium;* hyoscyamine in *A. Belladonna, D. stramonium,* and *Hyoscyamus niger;* hyoscine in *H. niger* and *Duboisia myoporoides.* Duboisine is nearly pure hyoscine. Pure atropine and pure hyoscyamine as well as hyoscine (?) are isomeric alkaloids, but possess different chemical and physical properties. By the action of baryta water both atropine and hyoscyamine split up into tropic acid and tropine. Hyoscine splits up into tropic acid and oscine.

Tropine and tropic acid may be recombined under certain conditions to form atropine, or tropine may be combined with other acids, such as salicylic or mandelic acid, to form salts. These salts, when treated with diluted hydrochloric acid, form a class of artificial alkaloids to which the generic name *tropeines* has been given. One of these so produced from the mandelate of tropine is *homatropine,* or *oxytoluyltropeine.* This body, like atropine, forms salts with acids.

Scopolamine, another exceedingly valuable mydriatic alkaloid, is obtained from the root of *Scopola carniolica.* It also contains the alkaloid hyoscyamine in comparatively large quantities and almost free from admixture with other mydriatic alkaloids. Given internally this drug produces less dryness of the throat than belladonna, and is probably more nearly allied to hyoscyamus in its action. Scopolamine is now regarded as identical with hyoscine.

ACTION AND USES.—Applied externally belladonna is anodyne and anesthetic. Internally the activity of the peripheral terminations of all the secretory nerves in the body is depressed. Dropped into the eye, solutions of belladonna or atropine quickly dilate the pupil and accommodation is paralyzed. Upon the heart it has a stimulating action; toxic doses abolish the function of the cardiac muscles and the heart stops in diastole. Dose: 1 to 3 gr. (0.065 to 0.2 Gm.); of atropine, $\frac{1}{64}$ to $\frac{1}{100}$ gr. According to Cushney, Hyoscyamine is twice as active as atropine in checking secretions and in pupil dilatation.

OFFICIAL PREPARATIONS.

Fluidextractum Belladonnæ Radicis, Dose: 1 to 3 ♏ (0.065 to 0.2 Cc.).
Linimentum Belladonnæ (95 per cent., with camphor 5 per cent.).
(**Emplastrum,** U. S. P., 1880.)

387. BELLADONNÆ FOLIA.

Ger. WOLFSKIRSCHEN-BLÄTTER.

The dried leaves of **Atropa Belladonna.**

DESCRIPTION OF DRUG.—As they come into market, these leaves are crumpled and broken, of a dull brownish-green tint, the under surface paler than the upper, and with a prominent woody midrib prolonged below into a petiole, margin entire; one of the characteristics is the small, circular holes puncturing the leaves by the dropping off of corky excrescences. This, however, applies in a less degree to the other narcotic leaves. It should be observed that the margins of the three narcotic leaves, belladonna, stramonium, and hyoscyamus, are quite different. Digitalis, sometimes called a narcotic leaf, has a *crenate* margin. When fresh the leaves are thick and fleshy and have a narcotic odor, but the dry leaves are thin, with a somewhat tea-like odor; taste somewhat bitter, saline. Under the microscope they present a grayish, granular appearance, due to numerous cells containing a crystalline principle. **The dried leaves should yield when assayed by the U. S. P. process not less than 0.35 per cent. of total alkaloids.**

Powder.—Green. Characteristic elements: Parenchyma of leaf and petiole with few raphides or aggregate crystals of calcium oxalate or crystal sand; stomata present; trichomes, simple, 2 to 5 celled, compound with stalk 1 to 3 celled and head one- to many-celled; ducts, spiral; tracheids, few.

CONSTITUENTS.—The alkaloids hyoscyamine and atropine (0.3 to 0.7 per cent.) are present. Belladonnine (oxyatropine) and other alkaloids of less importance exist, with chrysatropic acid.

ACTION AND USES.—Same as the root. Dose: 1 gr. (0.065 Gm.). The extract is employed in: Pil. Laxative Co. and Pil. Podophyl., Bellad. et Capsici.

OFFICIAL PREPARATIONS.

Tinctura Belladonnæ Foliorum (10 per cent.),................................Dose: 5 to 15 ♏ (0.3 to 1 Cc.).
Extractum Belladonnæ Foliorum (1.4 per cent. alkaloid), ... $\frac{1}{8}$ to $\frac{3}{4}$ gr. (0.008 to 0.048 Gm.).
Emplastrum Belladonnæ (30 per cent.).
Unguentum Belladonnæ (10 per cent.).

388. **MANACA.**—Portions of the root and stem of **Brunfel'sia hopia'na** Bentham, a Brazilian plant. Strongly recommended in chronic subacute rheumatism as a powerful alterative. Dose: 15 to 60 gr. (1 to 4 Gm.).

388½. SCOPOLA.—Scopola.

The dried rhizome of **Scopola Carniolica** Jacquin, yielding by U. S. P. process not less than 0.5 per cent. of its alkaloids.

Habitat.—Germany, Austro-Hungary, and adjacent regions.

Description of Drug.—From 25 to 100 mm. (1 to 4 in.) long and from 10 to 20 mm. (⅖ to ⅘ in.) thick, frequently sliced. The upper surface is beset with cup-shaped stem scars; externally, yellowish-brown to dark brown; wrinkled longitudinally, obscurely annulate, rough and nodular; fracture short, showing a yellowish-white bark, its corky layer dark-brown or pale brown, indistinctly radiate wood; pith rather hard, but becoming soft and spongy when macerated in

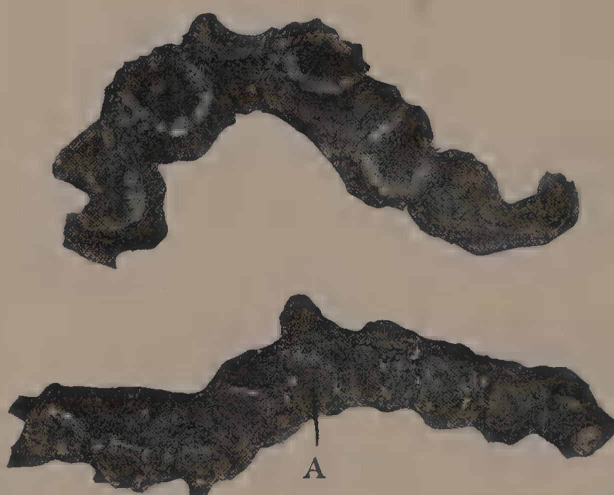


Fig. 166.—Scopola rhizome. A, Leaf scar. (½ natural size.) (Photograph.)

water. As compared to belladonna root, Coblentz concludes that scopola rhizome is more constant in alkaloidal content; that it is to be preferred to belladonna root in securing preparations of uniform standard ("Pharm. Era," 1900, p. 285).

Constituents.—Atropine, that has little optical activity. This alkaloid (atropine) has been assumed, by recent investigators, to be a simple mixture of right-handed and left-handed hyoscyamine. It follows therefore that a proper mixture of these two modifications would produce an optically inactive alkaloid. Both modifications have been isolated and physiologically studied. See Schlotterbeck's address before the Am. Phar. Assoc. ("Proc. Amer. Phar. Assoc.," 1903, p. 151). Scopolamine is regarded as identical with hyoscine. See Belladonna Radix.

Action and Use.—The action of scopola is about the same as that of bella-

donna, but preparations of the rhizome have not been professionally recognized until recently. The extract has been used as a substitute for the extract of belladonna in making of plasters. It has been stated that scopola costs about forty dollars per ton, while belladonna costs three hundred dollars per ton.

OFFICIAL PREPARATIONS.

Extractum Scopolæ,................Dose: $\frac{1}{5}$ gr. (0.010 Gm.).
Fluidextractum Scopolæ,.......... 1 ♍ (0.05 Cc.).

STRAMONIUM.—THORNAPPLE. JIMSON WEED.

The leaves and the seed are medicinal.

BOTANICAL CHARACTERISTICS.—**Datu'ra stramo'nium** Linné. Rank, narcotic, poisonous annuals. *Leaves* ovate, sinuate-toothed. *Corolla* white, funnel-form, the border 5-toothed. *Fruit* a 4-valved, 2-celled capsule, the outer side covered with prickles, longer toward the apex.

FIG. 167.—*Datura stramonium*—Branch showing flower and fruit.

HABITAT.—Europe, Asia, and North America; almost universally distributed.

389. STRAMONIUM.

Ger. STECHAPFELBLÄTTER.

The dried leaves of **Datu'ra Stramo'nium** Linné.

Description of Drug.—These leaves, which should be collected in early summer while the plant is in bloom, in the dried and broken state resemble somewhat those of belladonna, but are lighter in color; odor distinct, heavy, and narcotic; taste nauseous. **The drug should yield not less than 0.35 per cent. of total alkaloids.**

Powder.—Green. Characteristic elements: Spongy parenchyma of leaf with aggregate calcium oxalate; palisade parenchyma of leaf with cells long, narrow; parenchyma of petiole and stem with calcium oxalate in prisms; trichomes, glandular with stalk 1 to 2 celled, head 2 to 4 celled; non-glandular 2 to 3 celled with warty cuticular markings; stomata present.

Constituents.—**Daturine** 0.2 per cent., which, according to Ladenburg, is a mixture of atropine and hyoscyamine, with the latter usually predominating; it is said to be stronger than atropine.

Action and Uses.—Stramonium acts similarly to belladonna in every particular, but more strongly, and chiefly on the sympathetic system, without affecting the motor or sensory nerves. **Its chief use is in asthma,** the powdered leaves being sprinkled with a solution of potassium nitrate, dried, and smoked in a pipe, or ignited and the smoke inhaled. Dose: 1 to 5 gr. (0.065 to 0.3 Gm.).

Official Preparations.

Tinctura Stramonii Foliorum, ...	Dose:	10 to 20 ♍ (0.6 to 1.2 Cc.).
Fluidextractum Stramonii Folia,.....		1 to 3 ♍ (0.065 to 0.2 Cc.).
Extractum Stramonii,.............		$\frac{1}{5}$ gr. (0.010 Gm.).

390. **STRAMONII SEMEN.**—Off. in U. S. P. 1890. Small, somewhat reniform, flattened seeds, with a blackish testa covered with small indentations; the embryo, curved parallel with the convex edge of the seed, is imbedded in a whitish, oily albumen. Inodorous in the whole state, but with a peculiar disagreeable odor when crushed; taste oily, slightly acrid, bitter, and nauseous. *Constituents:* Daturine 0.3 per cent., combined with malic (daturic) acid, scopolamine, fixed oil, etc. Dose: 1 to 3 gr. (0.065 to 0.2 Gm.). A tincture, extract, and fluidextract were official in the U. S. P. 1890.

391. HYOSCYAMUS.—Henbane.

Ger. BILSENKRAUT.

The dried leaves and flowering tops of **Hyoscy'amus ni'ger** Linné, collected from plants of second year's growth, yielding by official assay not less than 0.08 per cent. of mydriatic alkaloids.

Botanical Characteristics.—Clammy, pubescent, fœtid, narcotic annuals or biennials. *Leaves* clasping, sinuate-toothed, and angled. *Flowers* sessile, in one-sided, sessile spikes in the axils of the leaves; *calyx* urn-shaped; *corolla* dull yellow, reticulated with purple veins. *Fruit* a 2-celled capsule.

SOURCE.—Europe and Asia; from biennial plants growing wild or cultivated in Britain, when about two-thirds of the flowers are expanded. The plant is found in the northeastern section of the United States in wet grounds, growing in great abundance about Detroit and in other parts of Michigan.

DESCRIPTION OF DRUG.—The fresh leaf is from 2 to 10 inches long, 1 to 4 inches broad, ovate to ovate-oblong in shape. On each side

FIG. 168.—*Hyoscyamus niger*—Flowering branch.

3 to 5 coarse, sinuate teeth or lobes, which are rather acute and oblong or triangular. On drying, the leaves shrivel and crumple up around the very large, light-colored midribs, and generally have the large petiole still attached; they are grayish-green, and of a coriaceous texture; leaves, in the market, are very much broken; odor heavy, narcotic; taste bitter and nauseous. **The drug when assayed by the U. S. P. process should contain not less than 0.08 per cent. of mydriatic alkaloids.**

Powder.—Dull green. Characteristic elements: Parenchyma of leaf, spongy; stomata present; calcium oxalate prisms about 10 μ in diam., sometimes aggregate; trichomes of different kinds, glandular, with stalks 1 to 4 celled, heads one- to many-celled; non-glandular, 1 to 5 celled.

CONSTITUENTS.—By distillation the leaves yield a very poisonous volatile oil, but the active principles are **hyoscyamine,** $C_{17}H_{23}NO_3$ (crystalline), and **hyoscine,** $C_{17}H_{21}NO_4$ (amorphous). They also contain about 2 per cent. of potassium nitrate, which causes them to crackle when thrown in the fire.

Preparation of Hyoscyamine from Seed.—First extract fatty matter; acidulate with HCl; evaporate; wash acid solution with benzene. Neutralize solution with NH_4OH, shake out with chloroform, and evaporate latter solvent.

ACTION AND USES.—Anodyne, hypnotic, narcotic. The action of hyoscyamus is that of its alkaloid, hyoscyamine, which acts like atropine but is less irritant and more calmative and hypnotic. Hyoscine is a decided anodyne and hypnotic. Dose of leaves: 5 to 15 gr. (0.3 to 1 Gm.); Hyoscyamine salts, $\frac{1}{100}$ gr. (0.0006 Gm.); Hyoscine hydrobromate (Scopolamine hydrobromate), $\frac{1}{100}$ gr. (0.0006 Gm.).

RELATED SPECIES.—*Hyoscyamus pallidus* (flowers pale yellow), *H. agrestis* (flowers few, leaves smaller), and *H. albus* (flowers white). The latter is used indiscriminately in France with the *niger*, with which it appears to be identical in medicinal properties.

VARIETIES.—There are two varieties of henbane, the annual and biennial. The former when properly grown are not devoid of active properties. The official plant is susceptible of considerable diversity of character. causing varieties which have been considered by some as distinct species, and by cultivation differing somewhat in medical properties.

OFFICIAL PREPARATIONS.

Tinctura Hyoscyami (10 per cent.), ...	Dose:	10 to 60 ♏ (0.6 to 4 Cc.).
Fluidextractum Hyoscyami, ...		1 to 3 gr. (0.065 to 0.2 Gm.).
Extractum Hyoscyami, ...		5 to 15 ♏ (0.3 to 1 Cc.).

392. **HYOSCYAMI SEMEN** (unofficial).—Used for the same purposes as the leaves and contain the same alkaloids, but in larger proportion, together with a large quantity of fixed oil and a bitter glucoside, hyoscyopicrin. They are small, reniform, and have a peculiar gray-brown surface, much wrinkled and finely pitted; near the raised portion of the testa they are rather sharp (distinction from stramonium seed). The embryo is curved so as to form a figure 9, the lower part of which is the radicle, and is surrounded by a whitish, oily albumen. Odorless in entire state, but when rubbed, of a distinctly narcotic odor; taste oily and bitter.

393. **TABACUM.**—TOBACCO. The leaves of **Nicotia'na taba'cum** Linné. Off. U. S. P. 1890. Large, oval, or oval-lanceolate leaves, often 500 mm. (20 in.) long when entire, but they are more generally somewhat broken; brown; thin; friable; the glandular hairs, so thick on the leaves when fresh, are scarcely discernible; short-petiolate; odor peculiar, heavy, narcotic; taste strong, bitter, and acrid. *Constituents:* **Nicotine,** $C_{10}H_{14}N_2$, nicotianine (a camphor), bitter extractive, salts, resin, etc. Nicotine is a volatile liquid alkaloid and a virulent poison; there is hardly any of it

contained in Turkish tobacco; by heat it is decomposed, yielding various pyridine compounds, hydrocyanic and acetic acids, etc.; these pass off in the smoke; the chief of these compounds are pyridine (in smoke from pipes), collidine (from cigars), lobeline, coniine, piperidine, sparteine, trimethylamine, etc.

Preparation of Nicotine.—Concentrated infusion made with acidulated water is treated with KOH and shaken with ether. The ethereal solution is precipitated with oxalic acid; the oxalate of the alkaloid thus precipitated is dissolved in boiling alcohol; evaporate to a syrup, agitate with ether, and make alkaline with KOH. On fractional distillation the colorless, oily alkaloid remains. It is very unstable.

Narcotic, sedative, diuretic, and emetic. It is rarely used in medicine. Dose: ½ to 2 gr. (0.0324 to 0.13 Gm.). Oil of tobacco is a pharmaceutical product, official in the U. S. P. in 1870, obtained by destructive distillation of coarsely powdered tobacco; it is a tarry liquid of offensive odor. Considerable oil is obtained by distilling the leaves with water. It contains nicotine (a dark, oily liquid).

394. **DUBOISIA.**—Duboisia. The leaves of **Duboi'sia myoporoi'des** R. Brown, a tall Australian shrub or small tree. The medicinal qualities of the leaves make the plant related to hyoscyamus and other narcotic plants of this order. Lanceolate, 75 to 100 mm. (3 to 4 in.) long and 12 to 25 mm. (½ to 1 in.) broad, tapering below into a short petiole; midrib prominent; margin entire; they are generally seen, however, in broken fragments of a brownish-green color; inodorous; taste bitter. They contain **duboisine** (a mixture of hyoscyamine and atropine), and their action is, therefore, nearly identical with that of belladonna, except that they are less of a cerebral excitant and more calmative and hypnotic.

395. **PICHI.**—The stems and leafy branches of a Chilian shrub, **Fabia'na imbrica'ta** Ruiz et Pavon. A terebinthinate diuretic, used in gravel, cystitis, and diseases of the genito-urinary tract when the kidneys are not inflamed. Dose of fluidextract: 30 ♍ (2 Cc.).

396. **DULCAMARA.**—Bittersweet. Woody Nightshade. The young branches of **Sola'num dulcama'ra** Linné. Off. U. S. P. 1890. Very small cylindrical pieces (branches cut in sections) about the thickness of a quill; externally longitudinally striate and marked with alternate leaf-scars; periderm light greenish-brown or greenish-gray, thin, overlaying a uniformly green, rather thick, inner bark. Wood whitish or yellow, with greenish spots, surrounding a central pith, or, as is generally the case, a hollow; it is in one or two circles, with large ducts and numerous one-rowed medullary rays. The bark consists principally of parenchymatous tissue. Inodorous; taste at first bitter, afterward sweet. *Constituents:* **Solanine,** the active alkaloid, and a glucoside termed **dulcamarin,** $C_{22}H_{34}O_{10}$, to which the taste of the drug is due; also resin, wax, gum, starch, and calcium lactate. Commercial Solanin is a mixture of Solanin and Solanidin. Solanidin is soluble in alcohol. Solanin is practically insoluble, excepting in boiling alcohol, 0.840. Solanin—a glucoside ("Amer. Drugg.," Nov. 10, 1902, p. 305.)

Preparation of Dulcamarin.—Digest aqueous infusion of the drug with animal charcoal; treat charcoal with alcohol. Precipitate aqueous solution of alcoholic extract with lead subacetate, wash, digest with alcohol, and decompose with H_2S. (For details of improved process, see "Amer. Drugg.," Nov. 10, 1902, p. 306.)

Dulcamara is feebly narcotic and anodyne, but is chiefly employed as an **alterative and resolvent** in skin diseases, particularly those of a scaly character. Dose: 1 to 2 dr. (4 to 8 Gm.).

Extractum Dulcamaræ Fluidum, U. S. P. 1890, ...Dose: 1 to 2 fl. dr. (4 to 8 Cc.).

397. **SOLA'NUM CAROLINEN'SE** Linné.—HORSE NETTLE. A 20 per cent. tincture of this herb has been recommended in epilepsy in doses of 30 to 60 ♍ (2 to 4 Cc.).

398. CAPSICUM.—CAPSICUM.

CAYENNE PEPPER. RED PEPPER. *Ger.* SCHOTTENPFEFFER.

The dried ripe fruit of **Cap'sicum fastig'iatum** Blume, deprived of its calyx.

BOTANICAL CHARACTERISTICS.—A small, rough, branched shrub, 1 to 2 feet high. *Leaves* ovate or lanceolate, entire, hairy. *Flowers* small, white, solitary, axillary, drooping. *Capsule* deep red, very pungent.

SOURCE.—Tropical America and Asia; cultivated.

DESCRIPTION OF DRUG.—The fruits vary in shape and size, but those most generally used are oblong, wrinkled, pendulous, pod-like berries,

FIG. 169.—*Capsicum fastigiatum*—Branch.

the largest (American), about the thickness of a finger, with a long, recurved apex; pericarp bright red, sometimes yellow, thin, translucent; it incloses two or three cells and contains numerous flat, reniform, whitish seeds, which are surrounded by a dry, loose parenchyma,

and fastened to a slender placenta; odor peculiar, very irritating, especially in powder or in the fresh state; taste fiery.

Powdered capsicum of the market consists of several species of capsicum ground up together. It is of a reddish color. This is especially true of the American capsicum, which is grown to a limited extent in Texas and Mexico, where it is ground and called "paprika." The African (Zanzibar) pod yields a powder of a greenish- or brownish-yellow color. The commercial variety known as Bombay yields a powder of a more yellowish color than the African, but is not at all like the reddish-orange powder resulting from the American pod. This color fades and disappears on long exposure to the light. It is often adulterated with sawdust and red lead; the former may be detected with the microscope, the latter by digesting the powder in dilute nitric acid, filtering, and adding a solution of sodium sulphate, which will throw down a white precipitate if any lead oxide is present.

STRUCTURE.—A microscopical examination for the distinction of the above varieties has been suggested. This test is based upon the size and character of the cells of the outer layer of the epidermis, the American having, in dimension, the largest and the African the smallest cell in the outer layer of the pericarp. The value of capsicum can be estimated only by assay.

Powder.—Brownish-red. Characteristic elements: Parenchyma of pericarp with yellowish-red oil globules and chromoplasts; parenchyma of endosperm with small aleurone and oil globules. The large, porous, wavy epidermal cell walls from seed and pericarp are characteristic and interesting. (Fig. 363.)

CONSTITUENTS.—**Capsaicin,** $C_9H_{14}O_2$, an exceedingly active pungent principle existing principally in the pericarp; **a volatile alkaloid** having an odor like coniine, supposed to be the result of a decomposition process during ripening of the fruit, as it does not exist in the unripe fruit; fixed oil, fat acids (oleic, palmitic, and stearic), and a red coloring matter (a cholesterin ester of the fat acids).

Preparation of Capsaicin.—Treat petroleum ether extract with alkali; pass CO_2 through the solution; collect crystals after standing. Soluble in ether, alcohol, benzene, and fixed oils.

ACTION AND USES.—Externally **rubefacient.** Internally a powerful **stimulant.** Its chief value medicinally is in the treatment of malignant sore throat and scarlet fever, used internally and as a gargle. Dose: 1 to 5 gr. (0.06 to 0.3 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Capsici (10 per cent.), ...	Dose: 15 to 30 ♍ (1 to 2 Cc.).
Fluidextractum Capsici, ...	½ to 2 ♍ (0.324 to 0.13 Cc.).
Oleoresina Capsici, ...	¼ to 1 ♍ (0.0162 to 0.065 Cc.).
Emplastrum Capsici.	

399. **LYCOPERSICUM ESCULENTUM** Miller.—TOMATO. The ripe fruit is said to exert a curative action on ulcerated mucous membranes, given internally and applied locally. Dose of fluidextract: 30 to 60 ♏ (2 to 4 Cc.).

SCROPHULARIACEÆ.—Figwort Family.

Herbs or rarely trees with didynamous *stamens*, and an irregular, usually 2 lipped, *corolla; fruit* a capsule. A large order of plants, containing a bitter glucoside.

Synopsis of Drugs from the Scrophulariaceæ.

A. *Leaves.*
 DIGITALIS, 400.
 Euphrasia, 401.
 Verbascum, 402.

B. *Rhizome.*
 LEPTANDRA, 403.

C. *Herbs.*
 Veronica Officinalis, 404.
 Scrophularia, 405.
 Chelone, 406.

400. DIGITALIS.—DIGITALIS.

FOXGLOVE. *Ger.* FINGERHUT.

The dried leaves of **Digita'lis purpu'rea** Linné, collected from plants of the second year's growth at the commencement of flowering.

BOTANICAL CHARACTERISTICS.—Biennial, hoary-pubescent. *Leaves* alternate, ovate-lanceolate, crenate, rugose. *Racemes* terminal, loose; *flowers* purple, sometimes white, hairy, and spotted within.

SOURCE.—The plant is indigenous to Southern and Central Europe, particularly in the western section, and grows wild as far north as Norway, also in Madeira and the Azores, and is cultivated in the United States. It is found on the edges of woody land and prefers sandy soil.

Considerable care should be exercised in obtaining the drug of a certain age, only the full-grown and fresh drug being collected during the second year of its growth. Care should also be used in its preparation for market and subsequent preservation, so as to avoid, as far as possible, exposure to light, air, and moisture.

DESCRIPTION OF DRUG.—The margin of this leaf is rather irregularly double crenate. In the market it comes in **wrinkled, velvety fragments,** the lower surface paler green than the upper, **softly pubescent,** especially along the midrib and veins; the midrib is prominent, but not so much so as in hyoscyamus; the venation forms **prominent meshes on the under surface** of the leaf, the principal veins joining the midrib at a very acute angle; odor slight and characteristic; taste strongly bitter.

ADULTERATIONS.—Other dried leaves are sometimes mixed with digitalis; the commonest of these are: *Inula conyza* (*Conyza squarrosa*), spike-

nard, and *Inula helenium*, both having entire, instead of crenate or serrate, margins, and the latter having its veins branching off at about right angles to the midrib; accidental impurities, such as comfrey leaves, *Symphytum officinale*, have been found. These are lanceolate and bear isolated stiff hairs.

Powder.—Dull green. Characteristic elements: Trichomes, glandular, with stalk one-celled, head two-celled; non-glandular, 2 to 5 celled, straight or curved with warty markings; stomata on lower surface only.

CONSTITUENTS.—The exact chemical composition of digitalis is a vexed question, but the latest analysis shows it to be composed of at least five principles: **digitalin,** $C_5H_8O_2$ (soluble in alcohol, insoluble in water), **digitalein** (soluble in water and alcohol), **digitonin,** $C_{27}H_{44}O_{13}$ (readily soluble in water, insoluble in alcohol, the diuretic principle), **digitin** (inert), and **digitoxin,** $C_{31}H_{50}O_{10}$, the most active ingredient, crystalline (insoluble in water, and sparingly soluble in alcohol, deposited as a sediment from the alcoholic preparations of the leaf). Digitoxin, by recent experimentation, is found to yield with hydrochloric acid digitoxigenin, $C_{22}H_{32}O_4$, and a glucose, digitoxose, $C_9H_{18}O_6$, the former in colorless crystals. Digitoxin is found to be an abundant constituent of the leaves—not of the seeds; the latter contain large quantities of digitogenin. The commercial digitaline is a mixture of these various principles. There are, however, on the market principles of similar name having quite different degrees of therapeutical activity. On the whole, it appears that

FIG. 170.—*Digitalis purpurea*—Flowering branch.

digitoxin and digitalin may be regarded as the two substances of definite composition, and of most definite and constant therapeutic action. The infusion is the best for diuretic action, the tincture or fluidextract for cardiac action.

Preparation of Digitalin.—A concentrated fluidextract is first treated with water acidulated with acetic acid and charcoal. The filtrate is neutralized with ammonia, then precipitated with tannin. The washed precipitate is then rubbed with lead oxide, boiled with alcohol, decolorized, and filtered. Evaporate to solid and wash with ether. In this way a digitalin of indefinite composition is obtained, consisting of such glucosides as digitin, digitonin, etc.

ACTION AND USES.—**Cardiac tonic and stimulant and diuretic.** It slows the heart's action and increases its force, and by stimulating the vascular nervous system causes contraction of the arterioles and therefore greatly increases arterial tension. Its efficient diuretic action in cardiac diseases is due to its peculiar effects upon the general and renal circulations. Dose: 1 to 2 gr. (0.065 to 0.03 Gm.). Dose of digitalin: $\frac{1}{60}$ to $\frac{1}{30}$ gr. (0.001 to 0.002 Gm.); much depends on the quality.

OFFICIAL PREPARATIONS.

Infusum Digitalis (1.5 per cent.), ...Dose:	1 to 4 fl. dr. (4 to 15 Cc.).
Tinctura Digitalis (10 per cent.), ...	5 to 30 ♏ (0.3 to 2 Cc.).
Fluidextractum Digitalis, ...	1 to 2 ♏ (0.065 to 0.13 Cc.).
Extractum Digitalis, ...	$\frac{1}{3}$ to 1 gr. (0.021 to 0.065 Gm.).

401. **EUPHRASIA OFFICINALIS** Linné.—EYEBRIGHT. The leaves of this common plant have been stated to be almost a specific in acute nasal catarrh, given in the form of infusion.

402. **VERBASCUM THAPSUS** Linné.—MULLEIN. Both the flowers and leaves of this field weed are used. Mullein contains a large proportion of mucilage, which makes it a good demulcent and emollient. Anodyne properties are also ascribed to it. Popularly used in pectoral complaints, especially consumption, in which it is said to relieve the cough and also to improve the nutrition. Dose: 2 to 3 dr. (8 to 12 Gm.), in infusion. The dried leaves are sometimes smoked for nasal catarrh.

403. LEPTANDRA.—LEPTANDRA.

CULVER'S ROOT. CULVER'S PHYSIC. *Ger.* LEPTANDRA WURZEL.

The dried rhizome and roots of **Veron'ica virgin'ica** Linné.

BOTANICAL CHARACTERISTICS.—*Stem* erect, 2 to 6 feet high. *Leaves* whorled, in 4's or 7's, very smooth, or sometimes slightly downy, lanceolate, serrulate. *Spikes* panicled; *corolla* small, pinkish, or nearly white; *stamens* much exserted.

HABITAT.—United States, east of the Mississippi.

DESCRIPTION OF DRUG.—Horizontal rhizome, 4 to 6 inches long, somewhat flattened, about the thickness of a quill, branched, generally broken into pieces an inch or more long; very hard and firm; from

a light to a dark brown color; upper side marked with broad stem-scars, under side beset with the remnants of the thin, fragile, wrinkled

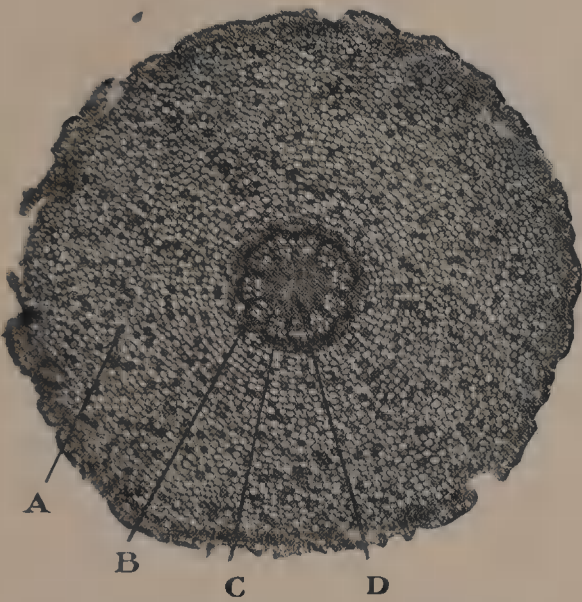


FIG. 171.—Leptandra—Cross-section of rootlet. (25 diam.) A, Parenchyma of cortex. B, Phloëm. C, Xylem. D, Medulla. (Photomicrograph.)

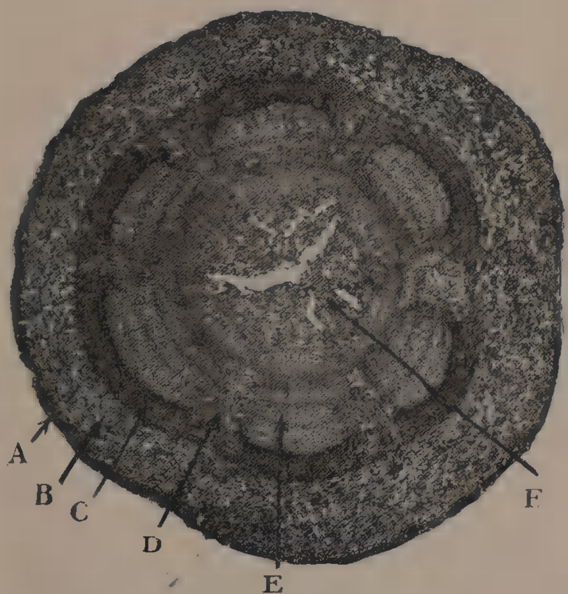


FIG. 172.—Leptandra—Cross-section of rhizome. (13 diam.). A, Cork. B, Parenchyma of cortex. C, Phloëm. D, Medullary ray. E, Xylem. F, Medulla. (Photomicrograph.)

rootlets. **Fracture** woody—bark thin, blackish, wood-circles one or two, yellowish, pith 6-rayed; tissue surrounding pith irregular and angular; inodorous; taste bitter and acrid.

Powder.—Brown. Characteristic elements: Parenchyma of cortex, isodiametrical or elongated with spherical starch grains (2 to 4 μ in diam.) and brown resin; sclerenchyma with bast fibers and narrow, thick-walled stone cells; ducts with scalariform, spiral, simple pores; tracheids, numerous; outer wall of epidermal rootlets very thick; considerable cork from rhizome.

CONSTITUENTS.—Besides tannin, gum, and a small quantity of volatile oil, it contains a crystalline glucoside, the active principle, which should be termed leptandrin instead of the resin or resinoid called by that name; this resinoid is obtained by precipitating a concentrated alcoholic tincture with water; its action is probably due to a small amount of the crystalline glucoside mixed with it.

Preparation of Leptandrin.—Remove coloring matter from infusion by basic acetate of lead, excess of lead removed by Na_2CO_3. Treat resulting liquid with animal charcoal. Extract washed charcoal with boiling alcohol; evaporate; dissolve in ether to purify. Upon evaporation needle-shaped crystals are obtained which are bitter; soluble in water, alcohol, and ether. The eclectic leptandrin is made by precipitating concentrated alcoholic tincture with water, and is a mixture of inert matter with pure leptandrin.

ACTION AND USES.—**Cholagogue cathartic.** Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Leptandræ, ...Dose:	15 to 60 ♏ (1 to 4 Cc.).
Extractum Leptandræ, ...	1 to 5 gr. (0.065 to 0.3 Gm.).
Pilulæ Catharticæ Vegetabiles (about ¼ gr. in each pill), ...	2 to 5 pills.

404. **VERON'ICA OFFICINA'LIS** Linné.—SPEEDWELL. Indigenous. (Herb.) Alterative, diuretic, and expectorant, in infusion.

405. **SCROPHULA'RIA NODO'SA** Linné.—FIGWORT. This indigenous herb is peculiar from the rank, fœtid odor of the leaves, especially when fresh. It has alterative, diuretic, and anodyne properties, and is used in hepatic diseases, scrofula, cutaneous diseases, dropsy, and as a depurative. Dose of fluidextract: 30 to 60 ♏ (2 to 4 Cc.).

406. **CHELONE.**—BALMONY. SNAKE-HEAD. The herb of **Chelo'ne gla'bra** Linné. *Habitat:* United States. Tonic, anthelmintic, and laxative, with a supposed peculiar action on the liver. It has been largely employed in domestic practice as an external application in diseases of the skin. Dose: 30 to 60 gr. (2 to 4 Gm.).

OROBANCHACEÆ.—Broom-rape Family.

407. **EPIPHEGUS.**—BEECH-DROP. CANCER-ROOT. The herb of **Epiphe'gus virginia'na** Barton, growing in all parts of North America as a parasite on the roots of the beech tree. It is a fleshy plant with a scaly, tuberous root, and smooth, yellowish or purplish stem, about 400 mm. (16 in.) tall, covered with small scales instead of leaves; taste bitter, astringent, and nauseous. It receives its name, cancer-root, from the popular belief that the powder was beneficial in the treatment of cancerous ulcers. It is often given as an astringent. Dose: 30 to 60 gr. (2 to 4 Gm.).

PEDALINEÆ.

408. **SESAMUM.**—BENNÉ. From **Se'samum in'dicum** Linné, a plant growing to the height of 4 or 5 feet, native to the East Indies, but long cultivated in Asia and Africa; from the latter country it was introduced by the negroes into Southern United States. Both the leaves and the seeds are used, and a fixed oil expressed from the latter.

THE LEAVES are oblong-lanceolate, from 75 to 125 mm. (3 to 5 in.) long, heart-shaped at base; pubescent, prominently veined beneath. They abound in a gummy matter to such an extent that two leaves stirred in a cup of water will make a sufficiently thick mucilage for use as a demulcent.

THE SEEDS are used chiefly as a source of the fixed oil, of which they contain from 50 to 60 per cent. They are used by the southern negroes as food. Ovate, flattened, about 3 to 4 mm. ($\frac{1}{8}$ to $\frac{1}{6}$ in.) long; externally yellowish-white to pale brown (in one species, *S. orientale*, purplish-brown), with four longitudinal ridges, and, on the pointed end, a somewhat prominent hilum; internally whitish, oily; taste bland.

408 a. **Oleum Sesami.**—TEEL OIL. BENNÉ OIL. A yellowish, limpid, transparent fixed oil, thinner at ordinary temperatures than most of the fixed oils; odor slight; taste bland, nut-like. It has a specific gravity of 0.919 to 0.923, and congeals to a yellowish-white mass at —5° C. (—23° F.). It is often used to adulterate olive and almond oils, in which it may be detected by shaking a portion of the suspected oil with an equal weight of concentrated hydrochloric acid; a bright emerald-green color will usually be produced, changing to blue, then violet, and finally to deep crimson on the addition of about one-tenth its weight of cane-sugar and agitating.

CONSTITUENTS.—Contains olein (76 per cent.), myristin, palmitin, stearin-resinoid compound, higher alcohol, $C_{25}H_{44}O$, sesamin, $C_{11}H_{12}O_3$, crystalline.

BIGNONIACEÆ.—Bignonia Family.

409. **NEWBOULDIA.**—The root-bark of **Newboul'dia læ'vis** Seeman, introduced from tropical Africa as an astringent in diarrhea and dysentery. Dose of fl'ext.: 15 to 60 ♍ (1 to 4 Cc.).

410. **CAROBA.**—The leaves of **Jacaran'da proce'ra** Sprengel. *Habitat:* South America. A valuable alterative and antisyphilitic. Dose of fl'ext.: 15 to 60 ♍ (1 to 4 Cc.).

VERBENACEÆ.—Vervain Family.

411. **LIPPIA MEXICANA.**—The leaves of **Lip'pia dul'cis** Treviranus. Demulcent and expectorant. Dose: 8 to 15 gr. (0.5 to 1 Gm.).

412. **VERBENA HASTATA** Linné.—AMERICAN BLUE VERVAIN. (Root and Herb.) The hot infusion is used as a sudorific in colds, etc. Also tonic and expectorant. Dose of fl'ext.: 30 to 60 ♍ (2 to 4 Cc.).

413. **VERBENA URTICÆFOLIA** Linné.—WHITE VERVAIN. *Habitat:* Tropical America. (Root.) Febrifuge. Credited with the cure of the opium-habit. Dose of fl'ext.: 30 to 40 ♍ (2 to 2.6 Cc.).

414. **TONGA.**—A drug introduced under this name has been found to be a mixture of bark, leaves, and woody fibers, tied into bundles by means of

the inner bark of the cocoanut tree. The bark comes from **Premna taitensis** (nat. ord. Verbenaceæ), a shrubby tree having a sweet and slightly astringent inner bark, containing little volatile oil, etc. The fibrous material comes from **Rhaphidophora vitiensis** (nat. ord. Araceæ), a creeper having a stem about the size of a quill, containing potassium chloride, a volatile alkaloid, tongine, etc. From this mixture a fl'ext. is prepared which has proved efficient in neuralgia. Dose of fl'ext.: 1 fl. dr. (4 Cc.).

LABIATÆ.—Mint Family.

One of the most natural groups of plants in the vegetable kingdom. Its members being so uniform, it would seem as if all of its species could be comprehended in a single genus; hence the characteristics of its different genera are very difficult to make out.

DESCRIPTION.—*Herbs* with opposite or whorled leaves. *Flowers* in axils of leaves or bracts, solitary or clustered cymes, scattered or crowded into spikes. *Calyx* sometimes 2-lipped, upper lip bifid, lower trifid, sometimes subregular. *Corolla* monopetalous, bilabiate, the upper lip entire or emarginate, the lower 3-lobed, sometimes bell- or funnel-shaped, with 4 subequal lobes (Mentha). *Stamens* 4, inserted on the corolla tube, didynamous (2 long and 2 short), or 2 by the abortion of the 2 upper (Lycopus, Salvia, Rosmarinus). *Ovary* 4-lobed. *Ovules* 4. *Style* simple, rising from the base of the ovarian lobes. *Fruit* separating into 4 akenes. *Stem* quadrangular, with volatile oil secreted in vascular glands.

GENERAL DESCRIPTION OF DRUGS OF THE ORDER.

In most instances the drug consists of dry herbs composed of leaves, or leaves and tops, with portions of stem, branches, and flowers. These are usually broken and intermixed. Odor aromatic, due to the secreted volatile oil; some species hold in solution a solid hydrocarbon (stearopten) analogous to camphor. Taste aromatic, pungent, cooling, and bitterish (marrubium). The odor and taste are frequently sufficient to distinguish the different drugs, but a knowledge of the size, shape, and marginal character of the leaves and their texture, and the character of the stem and branches is sometimes quite useful in the identification of the various drugs derived from the order.

Synopsis of Drugs from the Labiatæ.

A. *Herbs.*
- **MENTHA PIPERITA**, 415.
- **MENTHA VIRIDIS**, 416.
- **HEDEOMA**, 417.
- **MARRUBIUM**, 418.
- Melissa, 419.
- **SCUTELLARIA**, 420.
- Origanum, 421.
- Cunila, 422.
- Glechoma, 423.
- Lycopus, 424.
- Majorana, 425.
- Serpyllum, 426.
- Leonurus, 427.
- Monarda, 428.
- Hyssopus, 430.
- Cataria, 431.
- Teucrium, 432.
- Lamium, 433.

B. *Leaves.*
- **SALVIA**, 434.
- Rosmarinus, 435.
- Thymus, 436.
- Orthosiphon, 437.
- Pycnanthemum, 438.
- Satureia, 439.
- Yerba Buena, 440.
- Ocimum, 441.
- Monarda Fistulosa, 429.
- Betonica, 442.

C. *Flowers.*
- Lavandula, 443.

D. *Volatile Oils.*
- **OLEUM MENTHÆ PIPERITÆ**, 415 a.
- **OLEUM MENTHÆ VIRIDIS**, 416 a.
- **OLEUM HEDEOMÆ**, 417 a.
- Oleum Origani, 421 a.
- Oleum Monardæ, 428 a
- **OLEUM ROSMARINI**, 435 a.
- **OLEUM THYMI**, 436 a.
- **OLEUM LAVANDULÆ FLORUM**, 443 a.

E. *Stearopten.*
- **MENTHOL**, 415.

F. *Rhizome.*
- Collinsonia, 444.

415. MENTHA PIPERITA.—Peppermint.

Ger. PFEFFERMINZE.

The dried leaves and tops of **Men'tha piperi'ta** Linné.

Description.—Leaves petiolate, ovate, lanceolate, about 2 inches (50 mm.) long, acute, sharply serrate, glandular, nearly smooth; light or dark green flowers in terminal spikes, purplish; odor strong and

Fig. 173.—*Mentha piperita*—Flowering branch.

characteristic; taste pungent and cooling. Statistics show that 300,000 pounds of peppermint are annually consumed by the world, and that more than 90 per cent. of this is grown within 75 miles of Kalamazoo, Mich. The "mint" industry is a specialty with peculiar features, combining farm and factory—agriculture in growing the plant, and manufacture in separating the oil from the plant by distillation. There are about 80 "stills" in southwestern Michigan,

and since there are 4000 acres of the plant under cultivation, one "still" is required for every 50 acres of peppermint.

CONSTITUENTS.—Volatile oil, consisting of a terpene of complex composition (liquid) and menthol, $C_{10}H_{20}O$.

ACTION AND USES.—Carminative and diffusive stimulant. Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATION.

Spiritus Menthæ Piperitæ (1 per cent.), . . . Dose: 15 to 30 ♍ (1 to 2 Cc.).

415 a. OLEUM MENTHÆ PIPERITÆ, U. S.

A volatile oil distilled from peppermint. A colorless, or yellowish, or greenish-yellow liquid, turning darker and thicker by age and exposure to the air, having a strongly aromatic, pungent taste, followed by a sensation of cold when air is drawn into the mouth. Its composition is very complex, consisting of a number of terpenes, aldehydes, and acids: pinene, phellandrene, cineol, dipentene, limonene, menthone, and menthol, etc. In a freezing mixture the oil becomes cloudy and thick, and will separate crystals of menthol (415 b).

OFFICIAL PREPARATIONS.

Aqua Menthæ Piperitæ (0.2 per cent.), . Dose: 4 fl. dr. (15 Cc.).
Spiritus Menthæ Piperitæ (10 per cent.), 15 to 30 ♍ (1 to 2 Cc.).

415 b. MENTHOL.

A secondary alcohol from the official oil of peppermint (from *Mentha piperita* Smith), or from Japanese or Chinese oil of peppermint (from *Mentha arvensis* Linné, variety *piperasceus* Holmes, and *Mentha canadensis* Linné, variety *glabrata* Holmes). Colorless, acicular or prismatic crystals, having a strong and pure odor of peppermint, and a warm, aromatic taste, followed by a sensation of cold when air is drawn into the mouth. Dose: 0.06 Gm. (1 gr.).

416. MENTHA VIRIDIS.—SPEARMINT.

Ger. RÖMISCHEMINZE.

The dried leaves and flowering tops of **Men'tha spica'ta** Linné.

DESCRIPTION.—The leaves of the spearmint resemble those of the peppermint, but the former are rather subsessile. The branches of the spearmint are mostly light green, while those of the peppermint are

often purplish. The stamens of the spearmint are exserted, while those of the peppermint are short; odor and taste mint-like, but less cooling, quite characteristic.

CONSTITUENTS.—Volatile oil containing carvol, $C_{10}H_{14}O$, limonine, etc.

FIG. 174.—*Mentha viridis*—Flowering branch.

ACTION AND USES.—Carminative; an antispasmodic of milder property than peppermint, often preferred in infantile cases. Dose: 15 to 60 gr. (1 to 4 Gm.), in infusion, employed in Spiritus Menthæ Viridis.

416 a. OLEUM MENTHÆ VIRIDIS, U. S.

A volatile oil distilled from spearmint.

OFFICIAL PREPARATIONS.

Aqua Menthæ Viridis (0.2 per cent.).
Spiritus Menthæ Viridis (10 per cent.), ... Dose: 30 ♏ (2.0 Cc.).

417. HEDEOMA.—American Pennyroyal.

Ger. AMERIKANISCHER POLEI.

The dried leaves and tops of **Hedeo'ma pulegioi'des** Persoon.

Description.—*Stem* hairy; *leaves* ½ inch (12 mm.) long, short-petioled, oblong-ovate, slightly serrate; *flowers* in small axillary cymules, with small, pale blue, spotted, pubescent stamens; odor mint-like. Taste aromatic and pungent.

Fig. 175.—*Hedeoma pulegioides*—Flowering branch.

Constituents.—Volatile oil containing hedeomol, $C_{10}H_{18}O$, and pulegone. $C_{10}H_{16}O$. The oil obtained from *Mentha pulegium* Linné has about the same specific gravity and optical rotation, and contains pulegone.

417 a. OLEUM HEDEOMÆ, U. S.—Oil of Pennyroyal.

A volatile oil distilled from **Hedeoma pulegioides.**

418. MARRUBIUM.—HOREHOUND.

Ger. ANDORNKRAUT.

The dried leaves and flowering tops of **Marru'bium vulga're** Linné.

DESCRIPTION.—*Stem* white, tomentose; *leaves* roundish-ovate, about 1 inch (25 mm.) long, obtuse, crenate, downy; *flowers* whitish, aromatic, and bitter; *odor* distinct and agreeable; *taste* aromatic and bitter.

CONSTITUENTS.—Volatile oil in minute quantity, marrubiin, crystalline prisms soluble in hot water and ethereal solvents, insoluble in benzene.

Preparation of Marrubiin.—Treat the infusion with charcoal; exhaust latter with alcohol, which dissolves marrubiin and tannin; precipitate tannin with lead oxide; exhaust precipitate with alcohol. This leaves behind insoluble tannate of lead and dissolves the bitter principle.

ACTION AND USES.—A bitter tonic, laxative when given in large doses; employed in catarrh and chronic affections of the lungs attended by copious expectoration. Dose: 15 to 30 gr. (1 to 2 Gm.), in infusion or decoction.

419. **MELISSA.**—BALM. The leaves and tops of **Melis'sa officina'lis** Linné. Official U. S. P. 1890. Margin of leaves crenate, serrate, base rounded or rather heart-shaped, somewhat hairy; flowers in about four-flowered cymules, whitish or purplish; aromatic, astringent, and bitterish. *Constituents:* Volatile oil about 0.1 per cent., containing citral and citronellal (?). Carminative, stimulant, diaphoretic. Dose: 15 to 60 gr. (1 to 4 Gm.), in infusion or decoction.

420. SCUTELLARIA.—SKULLCAP.

Ger. HELMKRAUT.

The dried plant of **Scutella'ria lateriflo'ra** Linné.

DESCRIPTION.—*Leaves* 2 inches (50 mm.) long, somewhat ovate, serrate; *stem* smooth and branched; corolla pale blue; odor slight, taste bitterish. The other species of Scutellaria are sometimes collected as *S. integriafolia*, *S. pilosa*, and *S. galericulata*.

CONSTITUENTS.—A bitter crystalline glucoside, trace of volatile oil, tannin.

ACTION AND USES.—Tonic and antispasmodic. Dose: 30 to 60 gr. (2 to 4 Gm.), in infusion or fl'ext.

OFFICIAL PREPARATION.

Fluidextractum Scutellariæ, ...Dose: 30 to 60 ♏ (2 to 4 Cc.).

421. **ORIGANUM.**—WILD MARJORAM. The herb of **Ori'ganum vulga're** Linné, formerly used in making the Vinum Aromaticum, U. S P., 1880.

421 a. **OLEUM ORIGANI.**—OIL OF ORIGANUM is a favorite among some practitioners as an ingredient in various liniments.

422. **CUNILA.**—DITTANY. The herb of **Cunil'a marian'a** Linné. Carminative and sudorific. Dose: 15 to 60 gr. (1 to 4 Gm.).

423. **GLECHOMA.**—GROUND IVY. The herb of **Glecho'ma hedera'cea** Linné. Pectoral, tonic, and diuretic. Dose: 30 to 60 gr. (2 to 4 Gm.).

424. **LYCOPUS.**—BUGLE. The herb of **Ly'copus virgin'icus** Linné, and of **L. sinuatus** Elliott. Astringent, sedative. Dose: 8 to 30 gr. (0.5 to 2 Gm.)

425. **MAJORANA.**—SWEET MARJORAM. The herb of **Ori'ganum majora'na.** Carminative, stimulant, and emmenagogue. Dose: 15 to 60 gr. (1 to 4 Gm.).

426. **SERPYLLUM.**—WILD THYME. The herb of **Thy'mus serpyl'lum.** Carminative, stimulant, tonic, and emmenagogue. Dose: 15 to 60 gr. (1 to 4 Gm.).

427. **LEONURUS.**—MOTHERWORT. The herb of **Leonu'rus cardia'ca.** Tonic and expectorant. Dose: 30 to 60 gr. (2 to 4 Gm.).

428. **MONARDA.**—HORSEMINT. The herb of **Monar'da puncta'ta** Linné. Carminative, emmenagogue, and nervine. Dose: 15 to 60 gr. (1 to 4 Gm.).

428 a. **OLEUM MONARDÆ.**—OIL OF HORSEMINT. Used as an embrocation and as an addition to stimulating liniments.

429. **MONARDA FISTULOSA** Linné.—WILD BERGAMOT. Indigenous. (Leaves.) Introduced as a substitute for quinine; in large doses diaphoretic. Dose: 15 to 60 gr. (1 to 4 Gm.).

430. **HYSSOPUS.**—HYSSOP. The herb of **Hysso'pus officina'lis** Linné. Carminative, sudorific, and stimulant. Dose: 15 to 60 gr. (1 to 4 Gm.).

431. **CATARIA.**—CATNEP. The herb of **Nep'eta cata'ria** Linné. Carminative, stimulant, tonic, and diaphoretic. Dose: 15 to 60 gr. (1 to 4 Gm.).

432. **TEUCRIUM.**—GERMANDER. The leaves and tops of **Teu'crium chamæ'drys.** Aromatic stimulant; noted as an ingredient in the famous gout remedy known as Portland Powder.

433. **LAMIUM ALBUM** Linné.—DEAD NETTLE. (Herb.) An active hemostatic.

434. SALVIA.—SAGE.

Ger. SALBEIBLÄTTER.

The dried leaves of **Sal'via officin'alis** Linné.

DESCRIPTION.—About 2 inches (50 mm.) long, ovate, obtuse, base narrow to the long petiole, thickish, wrinkled, grayish-green, soft, hairy, and reticulated and glandular beneath; odor aromatic, taste bitterish and astringent.

CONSTITUENTS.—Volatile oil (0.5 to 0.75 per cent.), resin, tannin, etc. The volatile oil contains pinene, cineol, and salviol, $C_{10}H_{18}O$.

ACTION AND USES.—Stimulant, tonic, astringent, vulnerary, in infusion or decoction. Dose: 15 to 60 gr. (1 to 4 Gm.).

435. **ROSMARINUS.**—ROSEMARY. The leaves of **Rosmari'nus officina'lis** Linné. Rigid, linear, obtuse at summit, margin entire; odor strong, balsamic, and camphoraceous.

ACTION AND USES.—Carminative, stimulant, diaphoretic, emmenagogue. Dose: 3 to 15 gr. (0.2 to 1 Gm.).

435 a. **OLEUM ROSMARINI,** U. S.—OIL OF ROSEMARY. A volatile oil distilled from the leaves of **Rosmari'nus officina'lis** Linné.

OFFICIAL PREPARATIONS.

Tinctura Lavandulæ Composita (0.2 per cent.), ...Dose: ½ to 2 fl. dr. (2 to 8 Cc.).
Linimentum Saponis (1 per cent.).

436. **THYMUS.**—GARDEN THYME. The leaves of **Thy'mus vulga'ris** Linné. Carminative, tonic, antispasmodic. Dose: 30 to 60 gr. (2 to 4 Gm.).

436 a. **OLEUM THYMI,** U. S.—OIL OF THYME. Used as an antiseptic, etc. **Liquor Antisepticus,** U. S. P., contains 0.01 per cent.

THYMOL. (See Ajowan, 236.)

437. **ORTHOSIPHON STAMINEUS** Bentham.—JAVA TEA. (Leaves.) Used as a diuretic and in gravel. Dose of fl'ext.: 20 to 30 ♍ (1.3 to 2 Cc.).

438. **PYCNANTHEMUM MONTANUM** Michaux.—MOUNTAIN MINT. (Leaves.) Stimulant, tonic, and carminative. Dose: 15 to 60 gr. (1 to 4 Gm.).

439. **SATUREIA HORTENSIS** Linné.—SUMMER SAVORY. *Habitat:* Southern Europe; cultivated in our gardens. (Leaves.) Stimulant, carminative, and emmenagogue. Dose: 1 to 4 dr. (4 to 15 Gm.).

440. **YERBA BUENA.**—The leaves of a California plant, **Microme'ria douglas'sii** Bentham. A grateful aromatic stimulant, tonic, and emmenagogue. Dose of fl'ext.: ½ to 2 fl. dr. (2 to 8 Cc.).

441. **OCIMUM BASILICUM** Linné.—SWEET BASIL. (Leaves.) Aromatic, stimulant, and tonic.

442. **BETONICA.**—The leaves of **Sta'chys beto'nica** Bentham. Used in atonic dyspepsia, rheumatism, hepatic diseases, etc. Dose: 15 to 60 gr. (1 to 4 Gm.).

443. **LAVANDULA.**—GARDEN LAVENDER. The flowers of **Lavan'dula ve'ra** De Candolle. Calyx tubular, blue-gray, hairy, 5-toothed; corolla violet-blue, hairy, and glandular on the outside, tubular and 2-lipped; odor characteristic, somewhat camphoraceous. Stimulant and carminative. Dose: 15 to 30 gr. (1 to 2 Gm.).

443 a. **OLEUM LAVANDULÆ FLORUM,** U. S.—OIL OF LAVENDER FLOWERS. A volatile oil distilled from the fresh flowers of **Lavan'dula officina'lis** Chaix.

OFFICIAL PREPARATIONS.

Spiritus Lavandulæ (5 per cent. of the oil).
Tinctura Lavandulæ Composita (0.8 per cent. of the oil, with oil of rosemary, Saigon cinnamon, cloves, nutmeg, and red saunders). Dose, 30 ♍ (2.0 Cc.).

OIL OF SPIKE, used as an embrocation in rheumatic affections, is obtained by distillation of the leaves, tops, etc., of *Lavandula spica*.

444. **COLLINSONIA.**—STONE ROOT. The rhizome of **Collinso'nia canaden'sis** Linné. Long, with short, knotty branches and numerous stem-scars; hard; internally whitish; nearly inodorous; taste bitter and nauseous. Contains resinous matter. Diaphoretic, diuretic, and irritant.

PLANTAGINEÆ.

445. **PLANTAGO.**—PLANTAIN. The herb of **Planta'go ma'jor** and other species. Used principally in domestic practice, the leaves being externally applied as a stimulant application to sores, frequently in the form of a poultice, not infrequently applied whole.

CHENOPODIACEÆ.—Goosefoot Family.

Weed-like herbs, with minute greenish *flowers; ovary* 2-styled, 1-celled, becoming a 1-seeded thin utricle or caryopsis. Generally bland and innocent.

446. **CHENOPODIUM.**—American Wormseed. The fruit of **Chenopo'dium ambro'sioi'des** Linné, and variety **anthelmin'ticum** Gray. Off. U. S. P. 1890. A small, irregularly globular, seed-like fruit (utricle) not larger than a pin-head and of a grayish-yellow or brownish color. By rubbing the minute grains (fruit) in the hands, the capsular covering to the seeds is broken off, when the shining, lenticular, blackish seeds appear and a peculiar, strong, terebinthinate odor is rendered sensible. Taste pungent and bitter. The variety Anthelminticum gives a similar fruit, but is more aromatic. *Constituents:* Its medical properties depend upon a volatile oil, 3.5 per cent. (446 a), in which it, as well as all the other parts of the plant, abounds. Anthelmintic. Dose: 15 to 30 gr. (1 to 2 Gm.).

446 **a. OLEUM CHENOPODII,** U. S.—Oil of Chenopodium. A thin, yellowish, volatile oil, turning darker or brownish by age, having the peculiar odor and taste of the fruit. It is composed of a hydrocarbon and a heavier oil. Dose: 4 to 8 ♏ (0.25 to 0.50 Cc.).

PHYTOLACCACEÆ.—Pokeweed Family.

Tropical plants represented in the United States by *Phytolacca decandra* and *Rivinia lævis.*

447. PHYTOLACCA.—Poke Root.

Ger. KERMSBEERENWURZEL.

The dried root of **Phytolac'ca decan'dra** Linné, collected in autumn.

Botanical Characteristics.—*Stem* red, 3 to 8 feet high, smooth, with an unpleasant odor. *Leaves* large, petiolate, alternate, ovate-lanceolate, entire, cuspidate. *Racemes* lateral, opposite the leaves; *calyx* (perianth) white, lobes ovate, rounded at the apex; *ovary* bright green; *berries* dark purplish-red, pulpy.

Habitat.—North America; naturalized in West Indies and Southern Europe.

Description of Drug.—A large root, often 25 to 75 mm. (1 to 3 in.) in diameter, but cut into various sized **transverse or longitudinal slices** for drying and for the market; externally yellowish-brown, much wrinkled; **internally grayish,** turning yellow on exposure. **Structure loosely fibrous,** almost ligneous, alternating with dark, circular layers; a **transverse slice** shows on its face numerous concentric circles formed by the projecting ends of fibers between which the intervening parenchyma has shrunk; odor slight; taste sweetish, then acrid.

Constituents.—Resin, tannin, starch, gum, sugar, fixed oil, salts, and probably a glucoside. A trace of alkaloid is reported, but the

writer has found alkaloidal reaction quite pronounced in concentrated and purified solutions of the drug. Its virtues are imparted to water and alcohol.

ACTION AND USES.—Alterative, emetic, cathartic. It is not suitable for a cathartic, however, because of the narcotic effect often produced. Its most important use is as an alterative in chronic rheumatism, etc., and externally, in the form of ointment, in various skin diseases. Dose: 3 to 30 gr. (0.2 to 2 Gm.). Emetic in the larger dose.

OFFICIAL PREPARATION.

Fluidextractum Phytolaccæ, ...Dose: Emetic, 1.0 Cc. (15 ♍).
Alterative 0.2 Cc. (3 ♍).

FIG. 176.—Phytolacca—Cross-section of root. (Photograph.)

448. **PHYTOLACCÆ FRUCTUS.**—POKE-BERRIES. Globular, purplish or black, berry-like fruits, about 8 mm. ($\frac{1}{3}$ in.) or less in diameter, adhering together in masses from the exudation and drying of a purplish-red juice. Ten-celled, each containing a single glossy black seed imbedded in a succulent pulp. Inodorous; taste sweetish, slightly acrid, and nauseous. *Constituents:* **Phytolaccin, phytolaccic acid,** tannin, sugar, gum, and an evanescent coloring matter, turned yellow by alkalies and bleached by sunlight.

POLYGONEÆ.—Buckwheat Family.

Herbs or woody plants with alternate, entire *leaves*, and with the stipules in the form of sheaths above the smaller joints of the stem. *Fruit* an akene. The leaves and stem are very rich in crystals of calcium oxalate.

Synopsis of Drugs from the Polygoneæ.

A. *Roots.*
  RHEUM, 449.
  Rumex, 450.
  Canaigre, 451.

B. *Rhizome.*
  Bistorta, 453.

C. *Herb.*
  Polygonum, 452.

449. RHEUM.—Rhubarb.

RHUBARB. *Ger.* RHUBARBER.

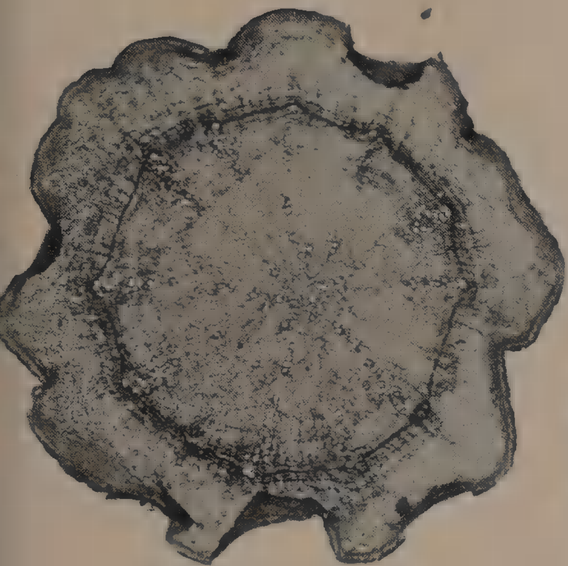
The dried rhizome of **Rhe'um officina'le** Baillon, **Rheum palmatum** Linné, and the Var. **Tanguticum** Maximowicz, and probably other species of Rheum, deprived of most of the bark.

Botanical Characteristics.—Botanical history somewhat obscure. It is known, however, from authentic specimens, that the plant is a herbaceous perennial with acidulous juice, resembling the garden rhubarb, but attaining a larger size than any other species. *Leaves* very large, roundish, cordate at base, and 5- to 7-lobed. The flower-stem, 6 to 8 feet high, bears *flowers* having a greenish perianth; *ovary* (and fruit) triangular, 1-celled.

Source.—Rhubarb is obtained from many species of Rheum, mostly natives of Asia, especially of China, Chinese Tartary, and Thibet. Russian or Turkish rhubarb—so called because all of it imported into these countries from China had to be submitted to official inspection—is now never found in the market. The caravan commerce between Russia and China has been an important one for many generations, and the rhubarb in European commerce was almost entirely carried from China through Persia and Asia Minor; hence the old name of Turkey rhubarb. Later on it was brought through Northern China, Siberia, and European Russia (Kiachta) to St. Petersburg. It is probable that the railway schemes of the Russian Government will, in the near future, make it likely that some portion of the Chinese product, now carried by steamer from the treaty ports of China to the European centers of population, will be deviated to the overland route through Siberia.

The "Russian rhubarb" of early times was evidently what is now known as Shensi variety. That brought into the trade by the port of Canton, known in Europe as Indian rhubarb, is now called Canton. The Chinese rhubarb is the variety recognized by the U. S. Pharmacopœia. The root is dug in the winter, often attaining a weight of fifty pounds, the cortical layer pared off, and it is then cut up into pieces of a suitable size for drying, holes being usually bored through the pieces and a string passed through for hanging them up.

Description of Drug.—In cylindrical, conical, or plano-convex pieces, or pieces with no regular shape, varying in size from 75 to 150 mm. (3 to 6 in.) long, and 50 to 75 mm. (2 to 3 in). thick; they are usually sorted into "round" and "flat" rhubarb. Externally somewhat shriveled, often with portions of the cortical layer which have not been pared away; usually covered with a bright yellow dust, beneath which it is seen to have a rusty-brown hue; under the lens it is seen to be marked with the medullary rays (innumerable short, broken



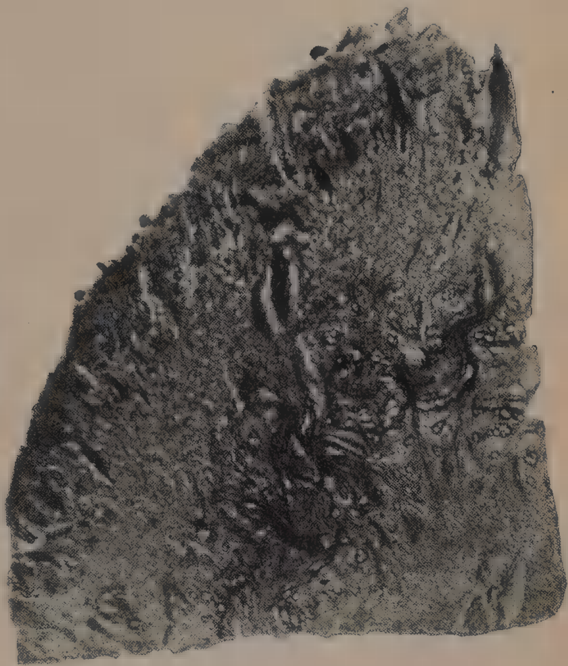


FIG. 1.—Cross-section of Canaigre root (*Rumex hymenosepalus*). × 5½. Photomicrograph.

FIG. 2.—Cross-section of Chinese Rhubarb. × 5½. Photomicrograph.

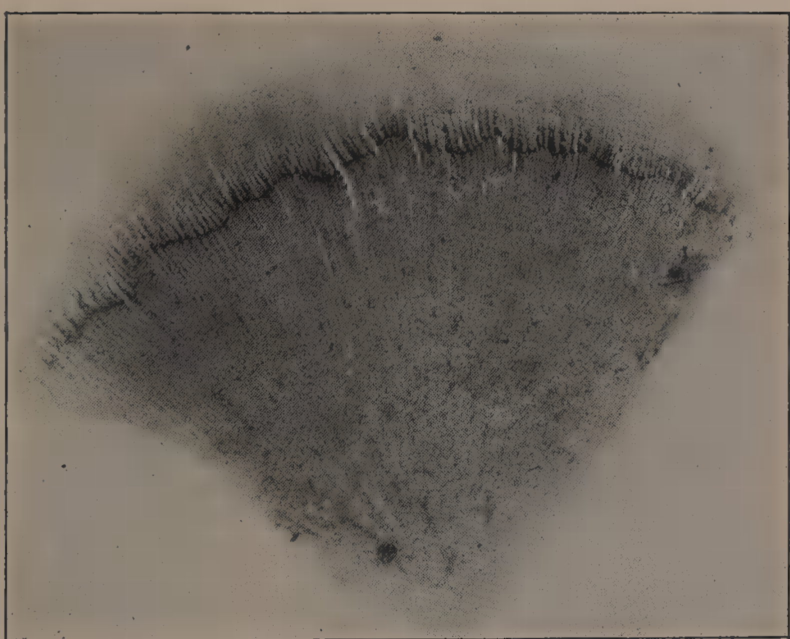


FIG. 3.—Cross-section of *Rheum rhaponticum*. × 5½. Photomicrograph.

lines of a deep brown color) crossing a white ground, forming elongated whitish meshes. Well-formed pieces broken transversely display near the cambium zone dark lines arranged as an internal ring of star-like spots, with radiating, reddish medullary rays, marking the internal origin of the leaves. Although this characteristic is not always obvious, it affords some help in distinguishing it from the European variety, in which these spots are absent entirely or occur very sparingly. **The tissue is made up** of a white parenchyma, with reddish-brown or brownish-yellow medullary rays, so twisted, however, as to be scarcely recognizable as such, giving a **cross-section a mottled appearance of red, white, and yellow.** The white parenchyma cells are loaded with starch and crystals of calcium oxalate, which causes the gritty feeling between the teeth; the medullary rays contain the active principle of the rhubarb. For illustration of structure of root see chapter on Powdered Drugs. Odor characteristic; taste bitter, aromatic, astringent, and gritty. When chewed, it tinges the saliva orange-yellow. It yields a **yellowish powder** with a reddish-brown tinge.

The common pie-plant, Crimean rhubarb, from *Rheum rhaponticum* Linné, is a European variety, having properties similar to that of rhubarb, but the astringent principles predominate. It is fusiform, about 100 mm. (4 in.) long and 20 mm. ($\frac{4}{5}$ in.) thick, with a thick orange-red cork, partially removed; **a cross-section** shows a comparatively regular, radiate structure of red medullary rays traversing a whitish parenchyma and extending into the cortical layer when present; its odor is less aromatic, is less gritty, and its taste more mucilaginous and astringent. *Rumex hymenosepalus*, Canaigre, has been used, in powder, to adulterate powdered rhubarb. For detection, follow general directions for examination of powders, page 664.

Choice of Rhubarb.—Select the moderately heavy and compact pieces, which should break with a brittle fracture, presenting a **lively, mottled appearance of yellowish and reddish fibers intermingled with white parenchyma;** odor decidedly aromatic; taste bitter, astringent, and gritty, not mucilaginous, tingeing the saliva orange-yellow when chewed. Very light, rotten, or worm-eaten pieces should be rejected.

Powder.—Brownish-yellow. Characteristic elements: Parenchyma cells, large, thin-walled; parenchyma of xylem, medullary rays, etc., with starch, simple (5 to 20 μ in diam.) 2 to 4 compound; calcium oxalate aggregate (50 to 100 μ in diam.); resin in masses, yellowish-brown; ducts, reticulate.

CONSTITUENTS.—Seemingly a mixture of different coloring principles of a somewhat resinous quality, each having a peculiar solubility of its

own: **Chrysophan, $C_{27}H_{30}O_{14}$** (and crysophanic acid), **emodin, aporetin, phæoretin, erythroretin, rheumic acid,** and **rheotannic acid;** also starch, calcium oxalate, pectin, and arabic acid. Chrysophan is a yellow glucoside yielding, with acidulated water, sugar and chrysophanic acid, $C_{15}H_{10}O_4$, yellow crystals, one of the best solvents for which is hot benzol. With the exception of aporetin (dark, resinous) the other neutral principles are more or less yellow-colored, but they differ in solubility, emodin, for example, being insoluble in benzol. According to Hagar, by proper extraction with chloroformic solvent, etc., rhubarb yields not less than 3 per cent. of chrysophanic acid. O. Hesse ("Pharm. Jour.," Fourth Series, I, 325–327) gives a process for the separation of chrysophanic acid, emodin, and rhein ($C_{15}H_6O_2(OH)_4$). Chrysophanic acid, or dioxy-methyl-anthraquinone ($C_{14}H_5CH_3(OH)_2O_2$) is closely related to emodin, which is a trioxy-methyl-anthraquinone ($C_{14}H_4CH_3(OH)_3$-O_2). **Cathartic acid** represents the cathartic principles of rhubarb in a crude but concentrated form. For its preparation, see Senna.

Preparation of Phæoretin.—Wash alcoholic extract with water; dissolve residue in a little alcohol; add ether. This precipitates crude phæoretin.

Preparation of Chrysophanic Acid.—Tincture of rhubarb, after standing for some time, deposits yellow sedimentary crystals. This sediment, dissolved in benzene, deposits the principle on evaporation.

Chrysarobin is a principle easily converted into chrysophanic acid by oxidation. The source of this is Goa powder (from *Andira araroba*). The powder is extracted with hot benzene (benzol), and the liquid allowed to cool. The orange-colored principle separates as the liquid cools.

Action and Uses.—**Purgative and astringent.** It has been highly esteemed as an antidysenteric remedy because of the fact that the cathartic principles are accompanied by the antiseptic action of chrysophan, and because catharsis is followed by an astringent and tonic effect upon the mucous lining. Roasting destroys the cathartic quality, when the root becomes simply a bitter astringent. Dose: 15 to 30 gr. (1 to 2 Gm.).

Official Preparations.

Tinctura Rhei (20 per cent., with cardamom), ... Dose:	1 to 4 fl. dr. (4 to 15 Cc.).
Tinctura Rhei Aromatica (20 per cent., with cassia cinnamon, cloves, and nutmeg), ...	½ to 3 fl. dr. (2 to 12 Cc.).
Syrupus Rhei Aromaticus (15 per cent. of aromatic tincture), ...	2 to 6 fl. dr. (8 to 24 Cc.).
Tinctura Rhei Dulcis (10 per cent., with glycyrrhiza, anise, and cardamom, 1890),	1 to 2 fl. dr. (4 to 8 Cc.).
Fluidextractum Rhei, ...	5 to 30 ♏ (0.3 to 2 Cc.).
Mistura Rhei et Sodæ (1.5 per cent. with sodium bicarbonate, fl. ext. of ipecac, and spirit peppermint),....	½ to 2 fl. oz. (15 to 60 Cc.).
Syrupus Rhei (Fl'ext. 10 per cent.),	2 to 6 fl. dr. (8 to 24 Cc.).

Extractum Rhei, ...	5 to 15 gr. (0.3 to 1 Gm.).
Pulvis Rhei Compositus (25 per cent., with magnesia and ginger), ...	1 to 3 dr. (4 to 12 Gm.).
Pilulæ Rhei (3 gr., U. S. P. 1890), ...	1 to 5 pills.
Pilulæ Rhei Compositæ (each pill containing about 2 gr. of rhubarb, with purified aloes 1½ gr., myrrh, and oil of peppermint), ...	1 to 3 pills.

450. **RUMEX.**—Yellow Dock. The root of **Ru′mex cris′pus** Linné, and of some other species of Rumex. Off. in U. S. P. 1890. A fusiform root from 100 to 200 mm. (4 to 8 in.) long and 10 to 15 mm. (⅖ to ⅗ in.) thick; **externally reddish-brown,** the upper portion annulate, the lower portion wrinkled; **fracture** short, exhibiting a rather thick cortical layer and a yellowish or whitish interior, somewhat mottled, the rather porous and horny wood-wedges separated by fine, distinct, reddish medullary rays; inodorous; taste astringent and bitter. Alterative, tonic, and astringent. Dose: 15 to 60 gr. (1 to 4 Gm.). **Extractum Rumicis Fluidum,** U. S. P. 1890. Dose: 15 to 60 ♏ (1 to 4 Cc.).

451. **CANAIGRE.**—The root of **Ru′mex hymenosep′alus** Torrey, from which a tannin is obtained. This plant resembles common dock, *Rumex crispus*, and flourishes in dry, barren, sandy soil in Southwestern United States and Mexico. It propagates by means of the roots, which grow in clusters of three or four. They are from 50 to 150 mm. (2 to 6 in.) long, and 25 to 50 mm. (1 to 2 in.) thick, reddish-brown to almost black. A cross-section shows a prominent cambium line and a broad radiating center. The tissue is chiefly parenchyma, containing starch, tannin, and a yellowish-red coloring matter. The tannin is yellowish-white, identical with that of rhubarb (rheotannic acid).

452. **POLYGONUM ACRE.**—Water Pepper. Smart Weed. (Herb.) Stimulant, diuretic, and emmenagogue. Dose: 1 to 2 dr. (4 to 8 Gm.).

453. **BISTORTA.**—Bistort. The rhizome of **Poly′gonum bistor′ta** Linné. *Habitat:* Europe, Northern Asia, and Northwestern United States, in moist places. An S-shaped rhizome (bent upon itself—bistorted), flattened, and transversely striate on upper side, and convex, with depressed root-scars, on lower side; color dark reddish-brown, internally lighter; fracture smoothish, showing a thick bark and a pith of about the same thickness as the bark. Contains tannin, 20 per cent., and starch, with red coloring matter. Tonic and astringent. Dose: 8 to 30 gr. (0.5 to 2 Gm.), in decoction.

ARISTOLOCHIACEÆ.—Birthwort Family.

Climbing shrubs, or low herbs, with perfect *flowers,* the lurid *calyx* coherent with the ovary, which forms a 6-celled capsule or berry in fruit. *Leaves* petiolate. Principal constituents are volatile oil and resinous principles.

454. SERPENTARIA.—Serpentaria.

VIRGINIA SNAKE-ROOT. *Ger.* VIRGINIANISCHE SCHLANGENWURZEL.

The dried rhizome and roots of **Aristolo′chia serpenta′ria** Linné (Virginia), and of **Aristolochia reticula′ta** Nuttall (Texas).

Botanical Characteristics.—*Stem* 8 to 15 inches high, pubescent. *Leaves* alternate, ovate, or oblong, with a heart-shaped or halberd-shaped base. *Flowers* all next the root, short-peduncled; *calyx-tube* bent like the letter S; *stamens* 6, the sessile anthers adnate to the fleshy style.

HABITAT.—United States (**Virginia and Texas**).

DESCRIPTION OF DRUG.—A rhizome about 25 mm. (1 in.) long, and about the thickness of a quill; contorted, bent up and down; externally light grayish-brown, with short stem-bases on the upper side and numerous long, fibrous, branching rootlets below, interlaced; internally grayish, closely matted. The bark is thin, overlaying quite a large woody zone, and separated into wood-wedges by broad medullary rays; **the pith is not in the center** but is nearer the upper side, making the lower wood-wedges the longest. **Odor faintly terebinthinate, characteristic**; taste warm, bitter, and camphoraceous. **Virginia and Texas Serpentaria** are both recognized by the U. S. P. The latter is about twice as large as the former, with fewer and thicker rootlets.

FIG. 177.—*Aristolochia serpentaria.*

ADULTERATIONS.—As found in commerce, serpentaria is frequently adulterated with portions of the stem. *Hydrastis canadensis* has

been used as an intentional adulteration; also spigelia. All of these may easily be distinguished from the genuine by their general characteristics.

Powder.—Grayish-brown. Characteristic elements: Parenchyma of cortex with spherical starch granules 10 μ in diam., simple or compound; some parenchyma with yellowish or dark brown contents; ducts with reticulate, spiral, annular, simple pores; short, porous wood fibers; cork, small amount (30 to 35 μ in diam.); resin present.

CONSTITUENTS.—Volatile oil ($\frac{1}{2}$ per cent.), containing borneol, aristolochine, $C_{32}H_{22}N_2O_{13}$ (very bitter), tannin, resin, starch, etc.

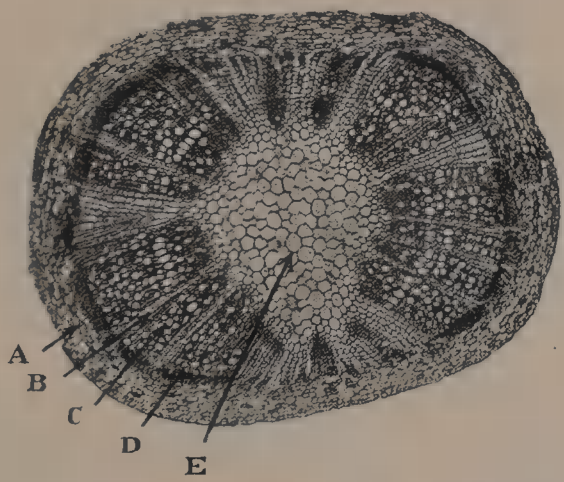


FIG. 178.—Serpentaria—Cross-section of rhizome. (25 diam.) A, Parenchyma of cortex. B, Medullary ray. C, Xylem. D, Phloëm. E, Medulla. (Photomicrograph.)

Preparation of Aristolochine.—Precipitate decoction with lead acetate; exhaust precipitate with hot alcohol; evaporate; dissolve out alkaloid with water. It is bitter, yellow, amorphous, or in needles; soluble in alcohol, water, precipitated by tannin.

ACTION AND USES.—Aromatic stimulant and tonic. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Serpentariæ (20 per cent.), ...	Dose: $\frac{1}{2}$ to 2 fl. dr. (2 to 8 Cc.).
Tinctura Cinchonæ Composita (2 per cent. of serpentaria), ...	1 to 4 fl. dr. (4 to 15 Cc.).
Fluidextractum Serpentariæ, ...	5 to 30 ♏ (0.3 to 2 Cc.).

455. **ASARUM CANADENSE** Linné.—CANADA SNAKE-ROOT. WILD GINGER. A long, creeping rhizome, more or less contorted. In commerce broken into pieces from 100 to 150 mm. (4 to 6 in.) long, from the thickness of a straw to that of a goose-quill; somewhat quadrangular or two-edged; externally grayish-brown, longitudinally wrinkled, beset with small fibers, easily broken off; internally nearly white, the small wood-bundles surrounding a large pith; odor peculiar, aromatic; taste aromatic and pungent. It contains a large percentage of volatile oil which is often used in perfumery. This contains asarol, probably identical with linalool, its acetic and valerianic esters, methyl eugenol. Aromatic stimulant and tonic. Dose: 30 gr. (2 Gm.).

PIPERACEÆ.

Herbaceous or shrubby tropical plants, with jointed stems, and *flowers*, destitute of floral envelopes, arranged in spikes or spicate racemes. The entire order possesses pungent and aromatic properties, due to the presence of volatile oil and resin.

Synopsis of Drugs from the Piperaceæ.

456. CUBEBA.—Cubeb.

CUBEBS. *Ger.* KUBEBEN.

The dried unripe but fully grown fruit of **Pi'per cube'ba** Linné filius.

Botanical Characteristics.—*Stem* climbing, rooting at the joints. *Leaves* 4 to 7 inches long, petiolate, oblong to ovate. *Flowers* diœcious, in spikes opposite the leaves. *Fruit* larger than black pepper, globose, on pedicels about ½ of an inch long.

Source.—Java, Sumatra, Borneo; also in West Indies. It grows extensively in coffee plantations or in grounds reserved for that purpose. The fruit after gathering is sent to Java, thence to Singapore, where it enters the market.

Description of Drug.—The official cubebs are picked while green, becoming **brown or black and reticulately wrinkled** on drying; they are about the size of a pea, **still attached to the slender stalk;** this stalk is longer than the fruit, and is formed by the downward lengthening of the pericarp, continuous with the prominent raised ridges on the surface of the berry. The shell or pericarp is hard, almost ligneous, and incloses a central cavity or a black, shrunken seed; **odor and taste** aromatic, spicy, pungent.

Powder.—Dark brown, wine color with H_2SO_4. Characteristic elements: Parenchyma of endosperm with small, simple starch grains and oil globules; stone cells, singly or in groups, thick-walled, very porous; reddish-brown tannin masses present with some tracheids; oil cells in fragments.

Adulterations.—Frequently adulterated with stems. Black pepper and other piperaceous fruits are often met with, but these are rarely intentional adulterants. *Rhamnus catharticus* (buckthorn berries) is sometimes used as an adulterant and may be readily distinguished by its four-seed fruit.

Constituents.—**Volatile oil** (5 to 18 per cent.), **cubebin,** $C_{10}H_{10}O_3$, **cubebic acid,** $C_{14}H_{16}O_4$, resin, fat, wax, and starch. Cubebin is a

colorless principle and forms the greater portion of the sediment which deposits from the official oleoresin on standing. Cubebic acid is the principle upon which depends the diuretic action of cubebs; the volatile oil is stimulating.

Preparation of Cubebin.—Precipitates from oleoresin, upon standing, in white, crystalline form; inodorous and bitter.

FIG. 179.—*Piper cubeba*—Fruiting branch and fruit (enlarged).

ACTION AND USES.—Stimulant, carminative, and diuretic. Its **especial action** is on the mucous membrane of the genito-urinary tract. Dose: 15 gr. to 2 dr. (1 to 8 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Cubebæ, ... Dose:	10 to 30 ♍ (0.6 to 2 Cc.).
Oleoresina Cubebæ, ...	5 to 30 ♍ (0.3 to 2 Cc.).
Trochisci Cubebæ ($\frac{3}{5}$ gr. of oleoresin in each troche), ...	1 or 2 troches.

456 **a. OLEUM CUBEBÆ,** U. S.—OIL OF CUBEB. A greenish volatile oil, becoming yellowish with age (colorless upon rectification), having the odor and taste of cubeb, but less pungent, and a warm, camphoraceous, aromatic taste. It has about the consistence of almond oil and is lighter than water. It is said not to preexist in the fruit, but to be formed by the prolonged action of the air. The oil consists of dipentene, cadinene, and cubeb camphor. Dose: 5 to 15 ♏ (0.3 to 1 Cc.).

457. PIPER.—PEPPER.

BLACK PEPPER. *Ger.* SCHWARZER PFEFFER.

The dried unripe fruit of **Pi′per ni′grum** Linné.

BOTANICAL CHARACTERISTICS.—Aromatic shrub, with knotted, pointed branches. *Leaves* alternate, entire. *Flowers* spicate, perfect, each supported by a scale. *Berry* 1-seeded.

HABITAT.—India and Cochin-China; cultivated in the East Indies.

DESCRIPTION OF DRUG.—A **black, reticulated, berry-like fruit,** resembling cubebs in size and general appearance, except that it is **destitute of the foot-stalk.** It is hollow inside and contains a single, small, undeveloped seed. Odor aromatic and sternutatory; **taste** sharp, burning, and acrid.

Powder.—Brown. Characteristic elements: Parenchyma of endosperm with cells, large, thin-walled, with starch (1 to 2 μ in diam.), some cells with resin; parenchyma of pericarp of reddish-brown cells; stone cells of pericarp present; some stone cells of testa, small, porous, outer walls very thin.

CONSTITUENTS.—The aromatic and stimulant properties of pepper depend upon its **volatile oil,** $C_{10}H_{16}$, but the pungent taste and medicinal activity are mainly due to a **soft, pungent resin, chavicin;** a neutral principle, **piperine,** is also present which is decomposed by alkalies into piperidine, $C_5H_{11}N$, and piperic acid, $C_{12}H_{10}O_4$. The latter yields piperinal (heliotropine) by oxidation.

Preparation of Piperine.—It is deposited almost pure from freshly made oleoresin; usually has pungent resin associated with it, giving it a biting taste. It is in pale yellow prismatic crystals; odorless, with sharp, bitter taste.

ACTION AND USES.—Stimulant and carminative, its principal use being as a condiment. The principle piperine has been used as an antiperiodic. Dose of pepper: 5 to 20 gr. (0.3 to 1.3 Gm.).

OFFICIAL PREPARATION.

Oleoresina Piperis, ... Dose: ¼ to 2 ♏ (0.016 to 0.13 Cc.).

Commercial oil of pepper is an oleoresin from which the piperine has crystallized out.

458. **PIPER ALBUM.**—WHITE PEPPER. The ripe fruit from which the epidermis has been removed by macerating in water and rubbing off. It is usually somewhat larger than black pepper and has a smooth surface with about ten distinct lines running from base to apex; the seed fills the whole inner cavity. It contains the same principles as black pepper; is seldom used except as a condiment.

FIG. 180.—*Piper nigrum*—Branch and fruit.

459. **PIPER LONGUM.**—LONG PEPPER. The fruit of **Pi'per lon'gum** Linné, and of **Pi'per officina'rum** De Candolle. *Habitat:* Southeastern Asia. It consists of cylindrical spikes of the fruits, 25 mm. (1 in.) or more in length; in the market they are of an earthy, grayish-white appearance, but exhibit their deep reddish-brown color when washed. The individual berries are ovoid, about 2.5 mm. ($\frac{1}{10}$ in.) long, with a nipple-like point at the apex and a bract at the base; they are arranged spirally on the axis. Medical properties same as those of black pepper, but they are inferior and seldom used.

460. MATICO.—Matico.

MATICO. *Ger.* MATICOBLÄTTER.

The leaves of **Pi'per angustifo'lium** Ruiz et Pavon.

Botanical Characteristics.—*Stems* jointed, about 12 feet high. *Leaves* short-petiolate, rough, and wrinkled, linear-lanceolate, acuminate. *Spikes* opposite the leaves; *flowers* perfect, yellowish; *stigma* sessile.

Habitat.—Tropical America.

Description of Drug.—The imported packages of this drug are composed of a mixture of broken leaves, stalks, and spikes; all are active, but the leaves only are recognized by the pharmacopœias. Although broken, they may be readily recognized by the **prominent veining** of the under surface; upper surface dull green, tessellated or checkered; odor slight; taste warm, aromatic, and bitter.

A South American plant, *Artanthe adunca*, furnishes a leaf very similar to matico in medicinal properties, but distinguished physically in not being tessellated, rough, and hairy. The reticulated upper surface and downy under surface are wanting in this leaf. It is probably not inferior in medicinal properties. Matico has a peculiar mechanical structure. To this structure is attributed the remarkable hæmostatic properties when either the leaf or powder is applied topically.

Constituents.—Volatile oil (about 2 per cent.), resin, tannin, a bitter principle, and artanthic acid; crystalline. On account of its action on the urinary passages it has been thought to contain a principle analogous to cubebin or piperin, but none has yet been found.

Action and Uses.—Aromatic, stimulant, and tonic, **its special action** being on mucous membrane; it also acts as a hemostatic and local styptic. Dose: ½ to 2 dr. (2 to 8 Gm.).

Official Preparation.

Fluidextractum Matico, ...Dose: ½ to 2 fl. dr. (2 to 8 Cc.).

461. **YERBA MANSA.**—The root of **Houttuy'nia califor'nica** Bentham and Hooker. Stimulant, tonic, and astringent; used with good results in malarial fevers. Dose of fl'ext.: 15 to 60 ♍ (1 to 4 Cc.).

462. **JAMBU ASSU.**—The root of **Pi'per jaboran'di** Vell. Used in its native country, Brazil, as a sudorific like pilocarpus. Dose: 15 to 30 gr. (1 to 2 Gm.).

463. **METHYSTICUM.**—Kava-kava. The root of **Pi'per methys'ticum,** obtained from a shrub indigenous to the Sandwich Islands. A large, woody, but spongy root, having a thin, grayish-brown bark and a yellowish meditullium which is radiate; usually comes in whitish segments. Odor fragrant, like a perfume rather than a spice; taste pungent, slightly benumbing. Used as a remedy in the treatment of diseases of the mucous membrane, as a tonic to the digestive organs, and stimulant to the nerves; also as a diuretic. It perhaps has some reputation as a remedy in gonorrhea.

MONIMIACEÆ.

462. **BOLDUS.**—BOLDO. The leaves of **Peumus boldus** Molina, an evergreen shrub growing in the Chilian Andes. They are broadly oval, about 50 mm. (2 in.) long, with entire margin and rough, reddish-brown surfaces, covered with numerous small glands containing a volatile oil; upper surface glossy, lower surface hairy; midrib prominent; odor fragrant; taste pungent, aromatic, somewhat bitter. They are used as an aromatic stimulant and tonic; in South America in inflammation of the genito-urinary tract. Dose: 15 to 60 gr. (1 to 4 Gm.), in fl'ext., tincture, or infusion.

MYRISTICACEÆ.

A. *Seed.*
  MYRISTICA, 465.
B. *Volatile Oil.*
  OLEUM MYRISTICÆ, 465 a.
C. *Fixed Oil.*
  Oleum Myristicæ Expressum, 465 b.
D. *Arillode.*
  Macis, 466.

465. MYRISTICA.—NUTMEG.

NUTMEG. *Ger.* MUSKATNUSS.

The kernel of the ripe seed of **Myris'tica frag'rans** Houttuyn.

BOTANICAL CHARACTERISTICS.—*Tree* about 30 feet high. *Leaves* oblong-oval, entire, glossy above, whitish beneath, aromatic. *Flowers* diœcious; *male flowers* in axillary clusters; *female flowers* single, solitary, and axillary, both very small and of a pale yellow color.

HABITAT.—Molucca Islands; cultivated in adjacent East India islands, and especially in the Dutch Banda Islands, whence most of the nutmegs are imported for market.

DESCRIPTION OF DRUG.—A roundish or oval kernel about 25 mm. (1 in.) long; externally light grayish-brown, marked with worm-shaped furrows and covered with lime (done by the Dutch growers to kill the germ, thinking in this way to monopolize its cultivation). They are hard and not readily pulverizable, but can easily be cut or grated, showing **a waxy luster; internally** yellowish, **a cross-section having a mottled appearance,** due to the penetration to the albumen of the inner seed-coat in narrow brown strips; these strips contain oily material; hilum and micropyle on the broad end, chalaza near the upper end, united by a groove corresponding to the raphé; the embryo is small, in a cavity at the base; **odor** strongly aromatic; **taste** warm and aromatic.

The male, wild, or long nutmeg, as it is variously termed, is occasionally found in market; it is much longer than the official nutmeg, elliptical, destitute of the dark brown inner veins, and of a bitter and disagreeable taste. Penang and Singapore nutmegs are unlined.

California nutmeg, so called, is the seed of *Torrega Californica*

(nat. ord. Coniferæ); testa smooth, brownish, internally marbled, resembling nutmeg, but has a terebinthinate odor and taste.

Powder.—Reddish-brown. Characteristic elements: Parenchyma of endosperm, cells large with spherical starch granules (5 to 7 μ in diam.), simple or 2-3-4-5 compound; or aggregate; fixed oil globules present; parenchyma cells of endosperm, reddish-brown, some contain resin and volatile oil.

FIG. 181.—*Myristica fragrans*—Branch and fruit.

CONSTITUENTS.—The greater portion of nutmeg (25 to 30 per cent.) consists of a **fixed oil**; this is official in the British Pharmacopœia and is called oil of mace or mace butter; it contains chiefly myristin, with some myristic acid, olein, palmitin, resin, and volatile oil (see 465 b). The aromatic properties of nutmeg depend upon 2 to 8 per cent. of **volatile oil.**

ACTION AND USES.—Aromatic stimulant and stomachic. Used as a cor-

rective and as a condiment. In large doses it possesses narcotic properties. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

OFFICIAL PREPARATIONS.

Pulvis Aromaticus (15 per cent., with cardamom, cinnamon, and ginger), ..	Dose: 10 to 30 gr. (0.6 to 2 Gm.).
Fluidextractum Aromaticum (from aromatic powder), ...	30 to 60 ♏ (2 to 4 Cc.).
Tinctura Lavandulæ Composita (1 per cent.), ...	½ to 2 fl. dr. (2 to 8 Cc.).

465 a. **OLEUM MYRISTICÆ,** U. S.—OIL OF NUTMEG. A thin, colorless or pale straw-colored volatile oil, lighter than water, and having the characteristic properties of nutmeg; on standing for a considerable length of time it becomes darker and thicker, and deposits a crystalline fatty glyceride of myristic acid. It contains a hydrocarbon, pinene, myristicin, and an oxygenated compound, myristicol, isomeric with carvol (?). Action and uses same as nutmeg, but rarely used. Dose: 1 to 3 ♏ (0.065 to 0.2 Cc.).

OFFICIAL PREPARATION.

Spiritus Ammoniæ Aromaticus (0.1 per cent.),.......	Dose: 30 ♏ (2 Cc.).

465 b. **OLEUM MYRISTICÆ EXPRESSUM.**—EXPRESSED OIL OF NUTMEG, MACE BUTTER (see Myristica Constituents). Unctuous blocks, marbled whitish and brown. Mostly used externally.

466. **Macis** (U. S. 1890).—The thick membrane or "arillode" immediately investing the kernel of the nutmeg. It comes in narrow bands, irregularly slit above into somewhat branched and lobed divisions, united at the base in an unbroken band; reddish or orange-yellow in color, with a fatty feeling when scratched or pressed; peculiar aromatic odor and taste. It contains volatile oil (about 8 per cent.), a red fixed oil, gum, resin, sugar, and proteids, but no starch. Aromatic stimulant and tonic; mostly used as a flavoring agent. Dose: 5 to 20 gr. (0.3 to 1.3 Gm.).

LAURACEÆ.—Laurel Family.

Aromatic trees or shrubs, all parts of which yield volatile oil. *Leaves* simple, alternate, pellucid-punctate.

Synopsis of Drugs from the Lauraceæ.

A. *Barks.*
- **CINNAMOMUM ZEYLANICUM,** 467.
- Cinnamomum Cassia, 468.
- **CINNAMOMUM SAIGONICUM,** 469.
- **SASSAFRAS,** 470.
- Nectandra, 473.
- Coto, 474.
- Lindera, 475

B. *Leaves.*
- Laurus, 476.
- Umbellularia, 477.

C. *Wood.*
- Sassafras Lignum, 471.

D. *Pith.*
- **SASSAFRAS MEDULLA,** 472.

E. *Stearopten.*
- **CAMPHORA,** 478.

F. *Volatile Oils.*
- **OLEUM CINNAMOMI,** 468 a.
- **OLEUM SASSAFRAS,** 470 a.
- **OLEUM CAMPHORÆ,** 478 a.

G. *Fixed Oil.*
- Oleum Lauri, 476 a.

H. *Seeds.*
- Persea, 479.

467. CINNAMOMUM ZEYLANICUM.

CEYLON CINNAMON. *Ger.* ZEYLONZIMMT.

The dried inner bark of the shoots of **Cinnamo'mum zeylan'icum** Breyne.

BOTANICAL CHARACTERISTICS.—*Tree* about 30 feet high. *Root* with the odor of camphor as well as that of cinnamon. *Leaves* ovate-lanceolate, entire, smooth and shining, tasting of cloves. *Flowers* in panicles, usually unisexual. *Drupes* 1-seeded, the seed large, with oily cotyledons.

HABITAT.—Ceylon.

DESCRIPTION OF DRUG.—Long, cylindrical quills deprived of the corky layer by scraping; **compound,** consisting of 8 or more thin, papery, light brownish-yellow, quilled layers, inclosed one within the other, their sides curling inward, giving the sticks a flattened appearance on one side; somewhat flexible, with a splintery fracture; the outer surface is marked with shining, wavy bast lines, and occasionally with small scars or perforations indicating the former position of leaves; under the microscope it is seen to be formed by a layer of stone cells. The inner surface is darker and striated. A characteristic, sweet, fragrant odor, and a warm, aromatic, pungent, and sweetish taste run through the different cinnamon barks, but the taste of the Ceylon cinnamon is the more delicate. The broken pieces, caused by repacking at custom-houses (sorted and sold as "small cinnamon"), are commonly used in pharmacy.

Powder.—Reddish-brown. Characteristic elements: Parenchyma of cortex with starch, spherical (7 to 15 μ in diam.), simple, 2 to 4 compound, also with tannin masses, and calcium oxalate raphides about 5 μ in diam., other large cells with resin and oil; sclerenchyma with bast fibers, rather short, thick-walled; stone cells single or in groups having walls usually unequally thickened; Ceylon cinnamon has no cork; as compared with Saigon, the bast fibers are longer and more pointed, stone cells larger, both more numerous; Saigon cinnamon fewer bast fibers and stone cells and regular cork cells with reddish-brown contents.

CONSTITUENTS.—Principally **volatile oil;** tannin, mucilage, a coloring principle, and an acid are also present.

ACTION AND USES.—Aromatic stimulant and tonic, carminative and astringent. The different varieties of cinnamon are among the most pleasant and efficient aromatics and form agreeable **adjuvants** to a great many official preparations. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Cinnamomi (10 per cent., U. S. P., 1890).
Pulvis Aromaticus (35 per cent., U. S. P., 1890).

468. **CINNAMOMUM CASSIA.**—CASSIA BARK. The bark of the shoots of one or more undetermined species of **Cinnamo'mum** grown in China (Chinese cinnamon). Off. U. S. P. 1890. Cassia cinnamon is in tubes or curved pieces, of a darker yellowish-brown color than preceding, nearly deprived

FIG. 182.—*Cinnamomum zeylanicum*—Branch.

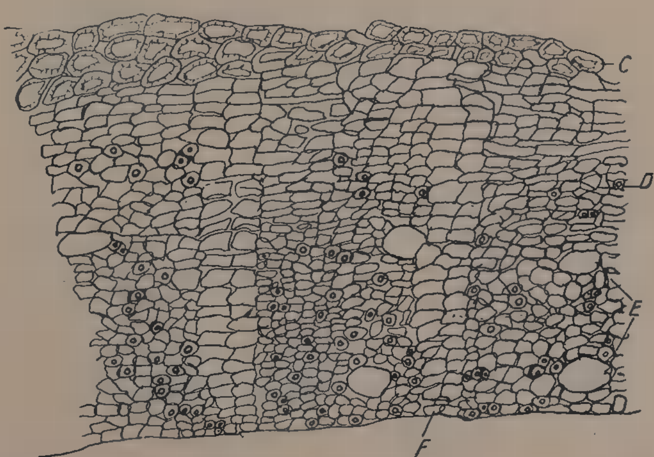


FIG. 183.—Ceylon cinnamon—Cross-section of bark. *C*. Stone cells. *D*. Parenchyma containing numerous bast fibers. *E*. Oil-resin cells. *F*. Medullary rays.

of the corky layer; these tubes are usually simple, rarely double, 1 mm. ($\frac{1}{25}$ in.) or more thick, and break with a rather short fracture; odor and taste similar to, but somewhat less delicate than, that of Ceylon cinnamon. Constituents the same, the volatile oil being officially recognized as from this source. This variety has been superseded by Saigon cinnamon in the official preparations containing cinnamon.

468 a. **OLEUM CINNAMOMI.**—Oil of Cinnamon. Contains at least 75 per cent. of **cinnamic aldehyde.** Both the Ceylon oil and that

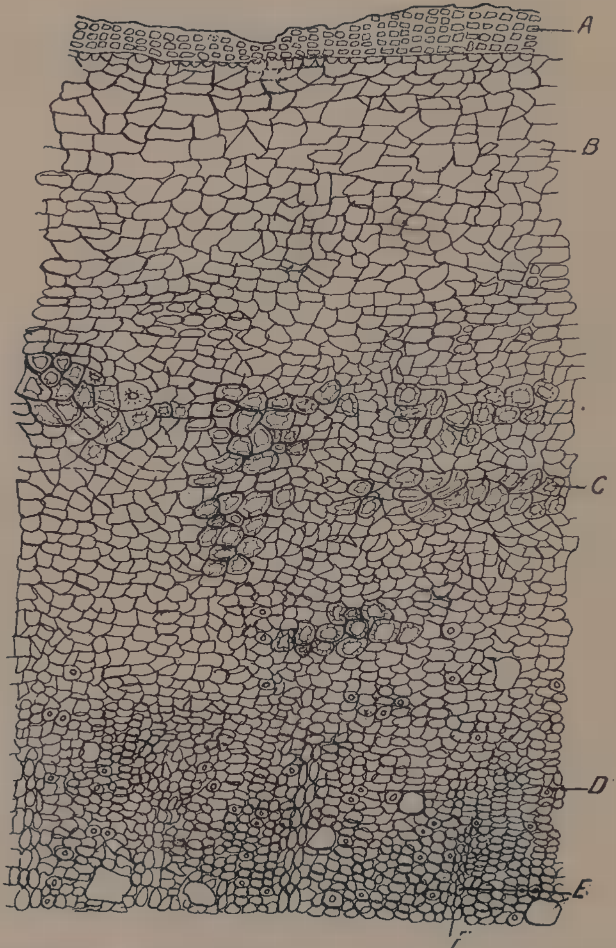


Fig. 184.—Cassia cinnamon—Cross-section of bark. *A*. Cork cells. *B*. Parenchyma cells. *C*. Stone cells. *D*. Bast fibers in parenchyma. *E*. Oil-resin cells (black line from *E* should have been directed to the large cell below and to the left of that letter). *F*. Medullary ray.

derived from Cassia, and other cinnamon barks are found in commerce, and they are essentially the same. The oil of Ceylon cinnamon has a more delicate odor and flavor. All of the various oils of cinnamon become darker and thicker by age and exposure to the air; they have the characteristic odor of cinnamon, a sweetish, spicy, and burning taste.

Constituents.—Oil of cinnamon consists chiefly of **cinnamic aldehyde,** with small quantities of hydrocarbon; when the oil is exposed to the air for a time, the cinnamic aldehyde is oxidized into cinnamic

Fig. 185.—*Cinnamomum cassia*—Branch.

acid, two resins, and water, the oil becoming thicker and darker, and frequently separating out a few crystals of the cinnamic acid.

Official Preparations.

Aqua Cinnamomi (0.2 per cent.), ...Dose: ½ to 1 fl. oz. (15 to 30 Gm.).
Spiritus Cinnamomi (10 per cent.), ... 10 to 20 ♍ (0.6 to 1.3 Cc.).

469. CINNAMOMUM SAIGONICUM.—Saigon Cinnamon.

SAIGON CASSIA. *Ger.* SAIGONZIMMT.

The dried bark of the stem and branches of an undetermined species of **Cinnamo'mum.**

Description of Drug.—It takes its name from Saigon, the capital of French Cochin-China, where it is collected and exported. It is in large quills or broken pieces, 1 or 2 mm. ($\frac{1}{25}$ to $\frac{1}{12}$ in.) thick; the gray or grayish-brown bark, which is not removed, is more or less rough and warty, longitudinally wrinkled and ridged, and covered with whitish patches. Inner bark cinnamon-brown or dark brown, with numerous white striæ near the bark; fracture short, granular; odor aromatic; taste aromatic and pungent.

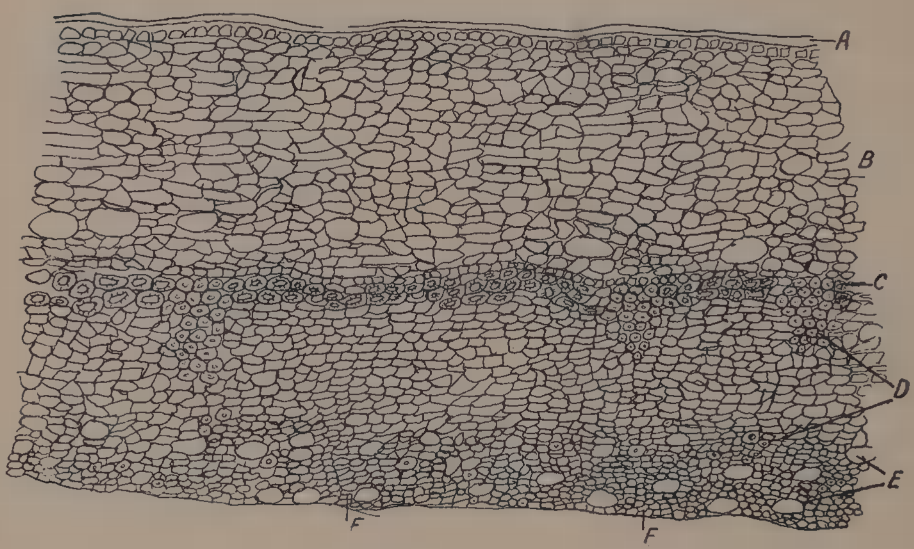


Fig. 186.—Saigon cinnamon—Cross-section of bark. *A*. Corky layer. *B*. Parenchyma cells. *C*. Stone cells. *D*. Bast fibers. *E*. Oil-resin cells. *F*. Medullary rays, very inconspicuous.

Comparison of the Cinnamon Barks.—*Color.*—There is quite a difference in the depth of the color of the three barks. The Ceylon is the lightest, the Saigon is the darkest, and the Cassia intermediate. This difference in shade is shown best in the powder.

Thickness.—The Ceylon is very thin and papery. The Saigon, usually regarded as the thickest, is in the average about the same as Cassia.

Odor.—The odor and taste of the Saigon is the strongest, the Ceylon is the most delicate, the Cassia weakest.

Microscopical.—To distinguish between the barks no difficulty is experienced in cross- and longitudinal sections, which display the oil-cells, stone cells, and other elements. In the powdered condition

the Ceylon shows the largest stone cells. In Cassia the stone cells are less numerous and smaller. In the Saigon the oblong stone cells are about the same size as those of Cassia, but fewer in number.

OFFICIAL PREPARATIONS.

Tinctura Cardamomi Composita (2.5 per cent.), ... Dose:	1 to 3 fl. dr. (4 to 12 Cc.).
Tinctura Gambir Composita (2.5 per cent.), ...	½ to 3 fl. dr. (2 to 12 Cc.).
Tinctura Lavandulæ Composita (2 per cent.), ...	½ to 2 fl. dr. (2 to 8 Cc.).
Tinctura Rhei Aromatica (4 per cent.), employed in Syrupus Rhei Aromaticus.	
Tinctura Cinnamomi (20 per cent.), ...	½ to 2 fl. dr. (2 to 8 Cc.). Employed also in Vinum Opii and Infusum Digitalis.
Pulvis Aromaticus (35 per cent.).....	15 gr. (1 Gm.).

SASSAFRAS.—SASSAFRAS.

Sas'safras variifo'lium O. Kuntze. The various portions used in medicine are the bark of the root, the volatile oil, and the pith, all official, and the wood, unofficial.

BOTANICAL CHARACTERISTICS.—Tree with spicy, aromatic bark, 15 to 125 feet high, with yellowish-green twigs. *Leaves* ovate, entire, or some of them 3-lobed. *Flowers* diœcious, greenish-yellow, in racemes.

HABITAT.—North America, from Kansas eastward.

470. SASSAFRAS.—SASSAFRAS BARK.

Ger. SASSAFRASRINDE.

The dried bark of the root of **Sassafras variifolium** O. Kuntze, collected in early spring or autumn and deprived of the periderm.

DESCRIPTION OF DRUG.—**In small, irregular, rust-brown fragments,** deprived of the grayish-brown, fissured, corky layer, leaving a reddish or rust-brown surface; 1 to 5 mm. ($\frac{1}{25}$ to $\frac{1}{5}$ in.) thick. It breaks with a short, corky fracture, exposing a whitish interior dotted with numerous oil-cells; **odor** highly fragrant, characteristic; taste sweetish, aromatic. Employed in the **compound syrup of sarsaparilla.**

Powder.—Reddish-brown. Characteristic elements: Parenchyma of cortex with starch (7 to 20 μ in diam.), single and 2 to 3 compound, tannin in irregular masses and oil globules; prisms of calcium oxalate very few; sclerenchyma with bast fibers (20 to 30 μ thick by 250 to 500 long); stone cells, porous, some very thick-walled; cork (30 to 40 μ in diam.), with bright red contents.

CONSTITUENTS.—**Volatile oil** (about 5 per cent.), camphoraceous matter, tannin (6 per cent.), sassafrid (a derivative of tannin, 9 per cent.), gum, resin, starch, etc.

ACTION AND USES.—Aromatic stimulant, alterative, and astringent. It is used almost entirely as an adjuvant or corrective. Dose: 30 to 120 gr. (2 to 8 Gm.), in infusion.

470 a. **OLEUM SASSAFRAS,** U. S.—A volatile oil usually distilled from the entire root. A colorless or yellow liquid, sp. gr. 1.065–1.075, becoming thicker and of a reddish color by age and exposure, and having the characteristic odor and taste of sassafras. It contains a hydrocarbon (safrene, $C_{10}H_{16}$), and an oxygenated compound, safrol, $C_{10}H_{10}O_2$ (melts at 8.5° C., 47.3° F.), a widely distributed principle obtained commercially from oil of camphor, phellandrene, $C_{10}H_{16}$, eugenol, $C_{10}H_{12}O_2$, etc. Generally used as a flavor. Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.).

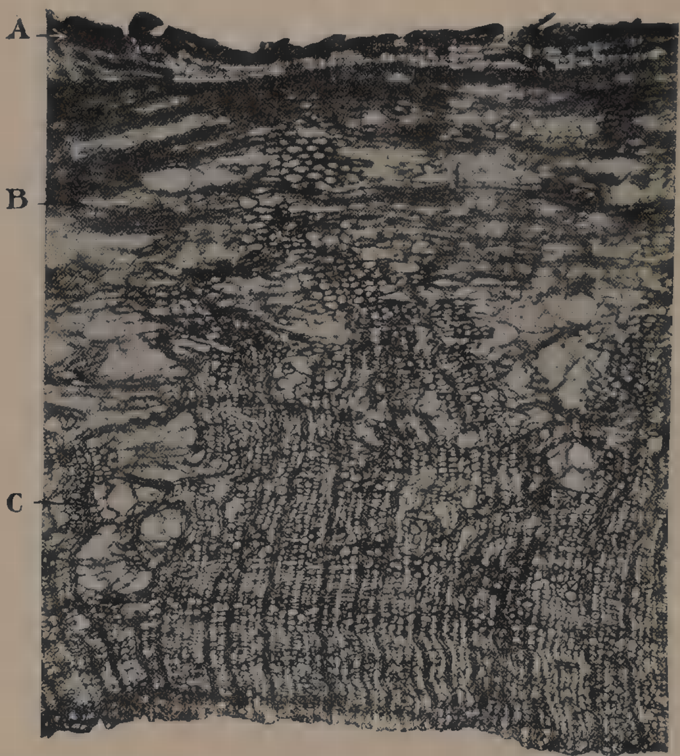


FIG. 187.—Sassafras—Cross-section of bark. (27 diam.) *A*, Cork. *B*, Parenchyma of primary cortex. *C*, Medullary ray. (Photomicrograph.)

471. **SASSAFRAS LIGNUM** (Unofficial).—SASSAFRAS WOOD. The wood of the root, coming in billets, partially or wholly deprived of bark, or in raspings or chips; pale brownish or reddish in color, light and easily cut; medullary rays narrow; odor and taste like the bark, but weaker, there being a smaller proportion of volatile oil. It is used like the bark.

472. SASSAFRAS MEDULLA.—SASSAFRAS PITH.

The dried pith of **Sassafras variifolium** O. Kuntze.

DESCRIPTION OF DRUG.—Thin, cylindrical, white pieces, very light and spongy; inodorous; taste insipid and mucilaginous. The tissue is

entirely composed of parenchyma. It contains a mucilage (not precipitated by alcohol or lead subacetate) which forms a limpid, ropy, viscid solution with water, but not sufficiently tenacious to hold insoluble substances in suspension. **Demulcent,** often used as an application to inflamed eyes.

OFFICIAL PREPARATION.

Mucilago Sassafras Medullæ (2 per cent.).

473. **NECTANDRA.**—BEEBERU BARK. GREENHEART BARK. From **Nectan'dra ro'diæi** Schomburgk. *Habitat:* South America. Large, flat, heavy pieces, from 250 to 300 mm. (10 to 12 in.) long, 50 to 150 mm. (2 to 6 in.) broad; usually deprived of the cork, leaving longitudinal depressions in the grayish-brown outer surface similar to the digital furrows of flat calisaya bark; internally pale brown, roughly striate. Its structure is chiefly short liber cells filled with secondary deposit, causing it to break with a short fracture. Inodorous; intensely bitter, somewhat astringent. It contains tannin, beberine (identical with buxine and pelosine), and sipirine.

ACTION AND USES.—Tonic, astringent, and **febrifuge,** introduced as a substitute for cinchona as an antiperiodic, but much inferior. Dose: 15 to 60 gr. (1 to 4 Gm.), commonly used in the form of beberine sulphate.

474. **COTO.**—COTO BARK. Origin undetermined. *Habitat:* Bolivia. Very large, flat pieces, about 5 to 15 mm. ($\frac{1}{5}$ to $\frac{3}{5}$ in.) thick, usually deprived of cork; the outer surface cinnamon-brown, rough, having the appearance of having been shaved or split off; inner surface darker brown, rough from numerous close ridges of longitudinally projecting bark fiber; a fresh cross-section shows numerous small, yellowish spots (groups of stone cells). Odor aromatic, cinnamon-like, stronger when bruised; taste hot, bitter.

Paracoto bark, which occasionally enters our market from Bolivia, very much resembles the above, but is marked with whitish fissures, and has a fainter, somewhat nutmeg-like odor.

CONSTITUENTS.—Cotoin, in true coto bark, paracotoin in the other; both barks contain volatile oil, resin, and piperonylic acid. They have established quite a reputation in diarrhœa. Dose: 5 to 10 gr. (0.3 to 0.6 Gm.).

475. **LINDERA BENZOIN** Meissner.—SPICE BUSH. (Bark, berries, and leaves.) Aromatic stimulant, tonic, and diaphoretic. The berries have been used as a substitute for allspice. Dose: 15 to 60 gr. (1 to 4 Gm.).

476. **LAURUS.**—LAUREL. SWEET BAY. The leaves of **Lau'rus nobi'lis** Linné. Oval-oblong, about 50 to 100 mm. (2 to 4 in.) long, brownish, pellucid-punctate; margin entire, wavy; taste aromatic, bitter, somewhat astringent; odor fragrant, due to a volatile oil. The chief constituent, however, is a fixed oil (see below) present to the extent of about 30 per cent. Stimulant and astringent, quite popular as an astringent injection.

476 a. **OLEUM LAURI.**—LAUREL OIL. A green, granular, semisolid of the consistence of butter. It consists mainly of laurostearin, but contains a small quantity of volatile oil which makes it a very aromatic base for liniments and ointments.

477. **UMBELLULARIA CALIFORNICA** Nuttall.—CALIFORNIA LAUREL. (Leaves.) They contain a volatile oil which seems to be a strong local anæsthetic, used in neuralgic headache, cerebro-spinal meningitis, intestinal colic, and atonic dyspepsia. Dose: 15 to 30 gr. (1 to 2 Gm.).

478. CAMPHORA.—Camphor.

GUM CAMPHOR. *Ger.* KAMPFER.

A stearopten (having the nature of a ketone) obtained from **Cinnamo'mum cam'phora** Nees et Ebermaier, and purified by sublimation.

Botanical Characteristics.—A large and handsome tree. *Leaves* evergreen, shining, alternate, ovate-lanceolate. *Flowers* small, perfect, in corymbose panicles; *anthers* 4-celled, opening by terminal pores.

Source.—The camphor tree grows in Japan and China, especially in the island of Formosa. This island alone furnishes half of the total product of the globe, or 5,200,000 pounds. Japan grows 1,560,000

Fig. 188.—*Cinnamomum camphora*—Branch and flower.

pounds. The rest comes from China, Java, Sumatra, and Florida. It should be mentioned that the camphor of Malaysia is not extracted from *Cinnamomum camphora*, but from *Dryobalanops aromatica.*

The United States alone uses 2,000,000 pounds of camphor yearly. The trunk, root, and branches are cut into chips and exposed to vapors of boiling water. The camphor volatilizes and condenses in small granules on the straw with which the head of the still is lined. It is freed from the volatile oil by draining or expressing, and is purified by resubliming with lime from a vessel into which the steam is allowed to escape through a small aperture. The camphor condenses in a compact cake, with a circular hole in the center corresponding to the aperture. Camphor has had to compete with rivals which are cheaper. In the manufacture of celluloid, the substitution of naphthalin for camphor has produced a considerable effect in controlling the high price resulting from the Japanese monopoly of the industry.

DESCRIPTION OF DRUG.—Refined camphor comes in **white, translucent masses,** tough and somewhat flexible, breaking with a shining, crystalline fracture; it is very difficult of pulverization by direct means, but may be easily reduced to a powder by the addition of a few drops of alcohol, ether, chloroform, glycerin, volatile or fixed oils, or other volatile liquids for which it has an affinity, by triturating with an equal weight of sugar, by precipitating the alcoholic solution with water, or by sublimation. It is very volatile, even at ordinary temperatures, giving out a **characteristic penetrating odor.** Taste pungent, aromatic, leaving a cooling sensation in the mouth. Lighter than water, small pieces taking up a circulatory motion therein, which ceases upon the addition of a drop of oil. This property has been put to account in the detection of fatty matter in liquids. When triturated with water it imparts a decided odor to it, although only about 1 part to 1000 goes into solution; its solubility is increased by the presence of sugar or magnesia. Very inflammable, burning with a dense smoke, and leaving no residue. When triturated with about molecular proportions of thymol, phenol, or chloral hydrate, it liquefies. It melts at 175° C. (347° Fahr.) and boils at 204° C. (399.2° Fahr.).

Borneo or Sumatra camphor is an allied camphor. By oxidation it yields ordinary camphor.

CONSTITUENTS.—Camphor has the composition $C_{10}H_{16}O$, and is considered as a ketone yielded indirectly by the oxidation of borneol, a secondary alcohol having the composition $C_{10}H_{18}O$. By treatment with various reagents camphor yields a number of interesting compounds, as cymol, camphoric acid, etc. With iodine and bromine it forms compounds, one, **the monobromated camphor** (Camphora Monobromata, U. S.), being used as a nerve sedative in doses of 3 gr. (0.2 Gm.); it is made by heating equal portions of bromine and camphor at 172° F.; one-half the bromine goes off as hydrobromic

acid, leaving the monobromated camphor—$C_{10}H_{15}BrO$. Camphoric acid, $C_{10}H_{16}O_4$, and camphronic acid, $C_9H_{12}O_5$, are produced by oxidation with nitric acid.

ACTION AND USES.—Stimulant and antispasmodic. Externally anodyne and rubefacient. Dose: 3 to 10 gr. (0.2 to 0.6 Gm.), in pill or emulsion.

OFFICIAL PREPARATIONS.

Aqua Camphoræ (0.8 per cent.), ...	Dose: ½ to 2 fl. oz. (15 to 30 Cc.).
Spiritus Camphoræ (10 per cent.), ...	5 to 40 ♏ (0.3 to 2.6 Cc.).
Tinctura Opii Camphorata (0.4 per cent.), ...	1 to 4 fl. dr. (4 to 15 Cc.).
Linimentum Camphoræ (20 per cent.).	
Linimentum Saponis (4.5 per cent.).	
Linimentum Chloroformi (70 per cent.).	
Linimentum Belladonnæ (5 per cent.).	

478 a. **OLEUM CAMPHORÆ.**—OIL OF CAMPHOR. Obtained in the sublimation of camphor from the wood. It is a reddish liquid with a slight yellowish tint, and is probably a mixture of a hydrocarbon and camphor. It resembles the latter in medical properties, but is more of a stimulant, and is especially applicable to those cases of bowel complaint or spasmodic cholera in which an anodyne and stimulant effect is wanted. This volatile oil must not be confounded with Linimentum Camphoræ, the common name for which, with many, is oil of camphor Dose: 2 or 3 ♏ (0.13 to 0.2 Cc.).

479. **PERSEA GRATISSIMA** Gaertner.—ALLIGATOR PEAR. (Seeds.) Used by the Mexicans as an anthelmintic, and, in the form of liniment, in intercostal neuralgia. Dose of fl'ext.: 30 to 60 ♏ (2 to 4 Cc.).

THYMELEACEÆ.—Mezereum Family.

Shrubby plants, with the bark containing strong bast fibers, and very bitter.

480. MEZEREUM.—MEZEREUM.

MEZEREON BARK. *Ger.* KELLERHALS.

The dried bark of **Daph'ne meze'reum** Linné, and of other species of **Daphne,** collected in early spring.

BOTANICAL CHARACTERISTICS.—A small shrub with smooth, evergreen, lanceolate *leaves.* *Flowers* spicate, appearing before the leaves, rose-colored, 4-lobed. *Berry* bright red, fleshy, 1-seeded.

HABITAT.—Mountainous regions of Europe, Siberia, Canada, and New England.

DESCRIPTION OF DRUG.—This bark comes to us in **tough, pliable strips,** from 2 to 4 feet long, 25 mm. (1 in.) or less broad, always rolled into bundles or balls; the very thin periderm is of a **greenish-orange or purple color,** marked with transverse scars and minute black dots; beneath it is a **soft, greenish parenchymatous layer,** from

which it separates easily. The inner surface is whitish, covered with irregular layers of **white silky bast fibers,** tangentially arranged. Fracture tough. Odorless; **taste exceedingly acrid.**

Powder.—Light brown. Characteristic elements: Outer parenchyma with chloroplasts and starch; prisms and aggregate calcium oxalate, and resin present; sclerenchyma with bast fibers, long, very slender, thin-walled, about 10 μ thick, quite characteristic; starch (10 to 15 μ in diam.), simple or compound.

FIG. 189.—*Daphne mezereum*—Fruiting branch and flowers.

CONSTITUENTS.—It contains a crystalline glucoside, daphnin, $C_{15}H_{16}O_9$, which is not the active principle, however, the medical virtues depending upon an acrid resin termed **mezerein.**

ACTION AND USES.—Sialagogue, stimulant, and alterative. Externally vesicant, in ointment or applied in the form of a small square, moistened. Dose: 1 to 8 gr. (0.065 to 0.6 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Sarsaparillæ Compositum (3 per cent.), ...	Dose: ½ to 1½ fl. dr. (2 to 6 Cc.).
Fluidextractum Mezerei, ...	1 to 8 ♏ (0.065 to 0.6 Cc.).

SANTALACEÆ.—Sandalwood Family.

481. **SANTALUM ALBUM.**—SANDALWOOD. The wood of **San'talum al'bum** Linné, and other species of Santalum. It comes in billets from 100 to 150 mm. (4 to 6 in.) in diameter, or in split slices; color varying, yellowish, whitish, or brownish; it has only a feeble taste, but an **aromatic odor,** particularly when rubbed or in powder. Contains from 1 to 4 per cent of volatile oil.

FIG. 190.—*Santalum album*—Branch.

481 a. **OLEUM SANTALI,** U. S.—OIL OF SANTAL. A yellowish, somewhat thick volatile oil, having a peculiar, strongly aromatic odor, and a pungently aromatic taste. It is a valuable remedy in inflammation of the mucous membrane, used especially in gonorrhea and bronchitis. Its principal use is in the manufacture of perfumery. Dose: 10 to 30 ♏ (0.6 to 2 Gm.).

LORANTHACEÆ.—Mistletoe Family.

482. **MISTLETOE.**—The bark of **Phoraden'dron flaves'cens** Nuttall, a parasitic evergreen growing on various trees, particularly on fruit trees. Laxative, oxytocic, and antispasmodic. As an oxytocic it is claimed to be superior to ergot. Dose: 15 to 60 gr. (1 to 4 Gm.).

EUPHORBIACEÆ.—Spurge Family.

Herbs, shrubs, or trees, usually with an acrid, milky juice, which in some cases yields rubber. A volatile oil is found in the bark of a few species, and a fatty oil is found abundantly in the seeds of other plants, as *tiglium* and *ricinus*.

Synopsis of Drugs from the Euphorbiaceæ.

A. *Roots.*
- **STILLINGIA**, 483.
- Euphorbia, 484.
- Euphorbia Corollata, 484 a.
- Euphorbia Ipecacuanha, 484 b.

B. *Herbs.*
- Euphorbia Pilulifera, 484 c.
- Mercurialis, 487.

C. *Gum-resins.*
- Euphorbium, 485.

D. *Concrete Juices.*
- Alveloz Milk, 486.
- **ELASTICA**, 488.

E. *Resin.*
- Lacca, 489.

F. *Bark.*
- Cascarilla, 490.

G. *Seeds.*
- Ricinus, 491.
- Tiglium, 492.
- Curcas, 493.

H. *Fixed Oils.*
- **OLEUM RICINI**, 491 a.
- **OLEUM TIGLII**, 492 a.

I. *Glands.*
- Kamala, 494.

483. STILLINGIA.—Stillingia.

QUEEN'S ROOT. QUEEN'S DELIGHT. *Ger.* STILLINGIE.

The dried root of **Stillin'gia sylvat'ica** Linné.

Botanical Characteristics.—*Stem* herbaceous, 1 to 3 feet high. *Leaves* alternate, nearly sessile, oblong-lanceolate, finely serrate. *Flowers* monœcious, in a terminal spike (the fertile flowers at the base), with saucer-shaped glands at the base of each; *stamens* 2 or 3; *style* 1; *stigmas* 3. *Capsule* 3-celled, 3-lobed, 3-seeded.

Habitat.—United States, from Virginia to Florida, in sandy soil.

Description of Drug.—A subcylindrical root, 300 mm. (1 ft.) long, 25 to 50 mm. (1 to 2 in.) or more thick, slightly tapering and sparingly branched; compact; fracture fibrous; odor distinct, peculiar, stronger and disagreeable when fresh; taste bitterish and pungent, persistently acrid.

The color of the exterior surface varies considerably, due, probably, to the varied character of the soils in which the plants grow. Roughly speaking, the roots would thus be classified into *light* and *dark* stillingias. By the accidental removal of their outer bark the pinkish inner bark is exposed. Transversely the woody cortex is seen to occupy about one-half of the diameter of the root. Around this is disposed the thick bark containing numerous bast fibers separately

imbedded in the parenchyma. The cambium line is composed of distinctly marked flat cells. Woody center radiate, through which numerous tracheids, arranged in four or five radiating rows that are quite regular in their disposition.

Powder.—Light reddish-brown. Characteristic elements: Parenchyma of cortex with starch, spherical or ellipsoidal, simple and compound (15 to 30 μ in diam.), calcium oxalate, aggregate, about 35 μ in diam.; sclerenchyma with bast fibers, very long, 20 μ thick, thick-walled, swelling with KOH; ducts, reticulate (25 to 50 μ in diam.); wood fibers, distinctly pitted (20 to 25 μ in diam.); cork cells with reddish-brown coloring-matter.

FIG. 191.—*Stillingia sylvatica*—Branch.

CONSTITUENTS.—The active principle has not yet been determined; it is probably a volatile principle, as old roots are nearly inert. An acrid resin (sylvacrol, soluble in alcohol and chloroform, insoluble in benzene), volatile oil, fixed oil, resin, starch, tannin, and gum have been separated. The so-called oil of stillingia, as found in the market, is intended to be the ethereal extract, but sometimes possesses very little of the persistent acrimony of the root.

ACTION AND USES.—An efficient **alterative** and antisyphilitic, usually given in combination, often with sarsaparilla, but more generally in the compound syrup of stillingia. Dose: 15 to 30 gr. (1 to 2 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Stillingiæ, ...Dose: 15 to 20 ♍ (1 to 2 Cc.).

484. **EUPHORBIA.**—There are a number of species of this genus yielding medicinal products:

484 **a. EUPHORBIA COROLLATA** Linné.—LARGE FLOWERING SPURGE. (Root.) Long, branched; externally purplish-black, wrinkled; internally whitish or yellowish. The medical virtues reside in the very thick, internally whitish bark, which constitutes about two-thirds of the whole root. Inodorous; taste sweetish, somewhat bitter and acrid. Emetic in doses of 10 to 20 gr. (0.6 to 1.3 Gm.); diaphoretic, expectorant, and cathartic in smaller doses.

FIG. 192.—Stillingia—Cross-section of root. (17 diam.) *A*, Cork. *B*, Parenchyma of Cortex. *C*, Medullary ray. *D*, Xylem. (Photomicrograph.)

484 **b. EUPHORBIA IPECACUANHA.**—IPECACUANHA SPURGE. (Root.) Has medical properties similar to the above. It is of a light brown color externally, with a thick bark inclosing a yellowish or whitish wood. The action of these two drugs is due to a resinous matter. Both are indigenous.

484 **c. EUPHORBIA PILULIFERA** Linné.—A common herb along the roadsides in Australia, where it enjoys a great reputation for the prompt and complete relief it gives in asthma and pectoral complaints generally. Dose: 15 to 60 gr. (1 to 4 Gm.).

485. **EUPHORBIUM.**—EUPHORBIUM. A gum-resin exuding from one or more undetermined species of **Euphorbia,** ascribed to some leafless, cactus-like plants of Egypt, Arabia, and the East Indies. It occurs in dull brownish-yellow or reddish, rounded pieces of the size of a pea or larger, often pierced with, or inclosing, the spines around which it has hardened on the stem of the plant; almost inodorous, the powder sternutatory; taste

mild at first, but afterward intensely acrid and burning. Only used externally, mostly in veterinary practice as a vesicant.

486. **ALVELOZ MILK.**—The milky juice of a Brazilian plant, **Euphor'bia heterodox'a** Müller. It has an action resembling that of papain, and is used in eating out cancerous and other ulcers.

487. **MERCURIALIS ANNUA** Linné.—Mercury Weed. A European herb, employed from the most ancient times as a purgative and emmenagogue.

488. ELASTICA.—India-rubber.

CAOUTCHOUC. *Ger.* KAUTSCHUK.

The prepared milk-juice of **He'vea Braziliensis** Mueller and other species, known in commerce as Para rubber.

Botanical Characteristics.—Large trees containing a milky juice which, on hardening, forms india-rubber. **Ficus elastica,** producing the greatest quantity, has its seeds germinate in the forks of the tree, giving off aërial roots which descend to the ground and form a great many trunks.

Habitat.—South America and India, the finest quality coming from Brazil.

Description.—Large, flat pieces, or molded into various shapes—balls, hollow, bottle-shaped pieces, etc. When the juice first hardens it is yellowish-brown externally and yellowish-white within, but in the processes of molding and drying it acquires a smoky, blackish appearance; very elastic; odor peculiar. Insoluble in water and alcohol, but soluble in chloroform, carbon bisulphide, and benzin. The common adulterants are the carbonates of zinc and lead; when pure or nearly pure, india-rubber should float in water.

Constituents.—The elastic principle has been termed caoutchouc; it, or a similar principle, is contained in a great number of milky-juiced plants.

Uses.—On account of its insolubility it has no therapeutic application, but is extensively used in the arts. It is recognized by the Pharmacopœia and employed in some of the official plasters, *e. g.*, Emp. Adhæsivum.

489. **LACCA.**—Lac. Gum-lac. A resinous exudation from punctures, made by insects, in the bark of several East Indian trees, and also in plants growing in Arizona and other Western States. The twigs, with their deep reddish-brown incrustations, are called **stick-lac. Seed-lac** consists of the small, irregular fragments broken off from the twigs. **Lump-lac** is made by melting the stick-lac, and, after it has hardened, breaking the brown, translucent mass into lumps. **Shell-lac** or gum-shellac, the most common form, is prepared by spreading the melted lac out in thin layers, which, on drying, form thin, brittle sheets, glossy, more or less transparent, varying from amber to dark brown in color; in packing, these sheets are broken into fragments, in which form shellac is commonly met with in market; odorless and tasteless. Lac contains several resins, laccin (a peculiar principle insoluble in alcohol), and a coloring matter varying in quantity in the different forms; this coloring matter, "lac dye," is equal to cochineal dyes; it is soluble in water, being obtained from the washings in making

the different forms of lac. Lac is not used medicinally, but is extensively employed in the arts for making varnishes and sealing-wax.

490. **CASCARILLA.**—CASCARILLA BARK. The bark of **Cro'ton elute'ria** Bennet. Small broken quills having a grayish fissured cork, more or less covered with white lichen patches, but often partially or wholly removed, showing the dull brown inner bark; inner surface smooth; bast fibers few; fracture short, resinous; odor feeble, stronger when rubbed; when ignited, it emits a strongly aromatic odor, somewhat resembling musk, but weaker and

FIG. 193.—*Croton eluteria*—Branch.

more agreeable; taste warm, aromatic, very bitter. Copalchi bark (see also Aspidosperma, 353) has a cascarilla-like odor, and melambo bark, from *Croton Melambo*, Venezuela, and other species of Croton, are similar to cascarilla. *Constituents:* **Volatile oil** (1.5 to 3 per cent.); **cascarillin** (a bitter crystalline principle), tannin, fat, resin, etc. Aromatic, stimulant, and tonic. Once used as a febrifuge as a substitute for cinchona. Dose: 15 to 30 gr. (1 to 2 Gm.).

491. **RICINUS.**—CASTOR-OIL SEED. The seeds of **Rici'nus commu'nis** Linné (Palma Christi), a herbaceous plant about 4 to 6 feet in height, native to

India, but cultivated in tropical and warm temperate countries; stems hollow, purplish-red; leaves large, palmately 9-divided, on long petioles, with glands at the apex of the petiole; flowers monœcious, in terminal panicles, the lower ones male, the upper female; male flowers—stamens numerous; female flowers—style 1, stigma 3, colored red; capsule covered with prickles, 3-celled, each cell containing one seed.

The seeds are about the **size of a bean,** oval-oblong, flattened on one

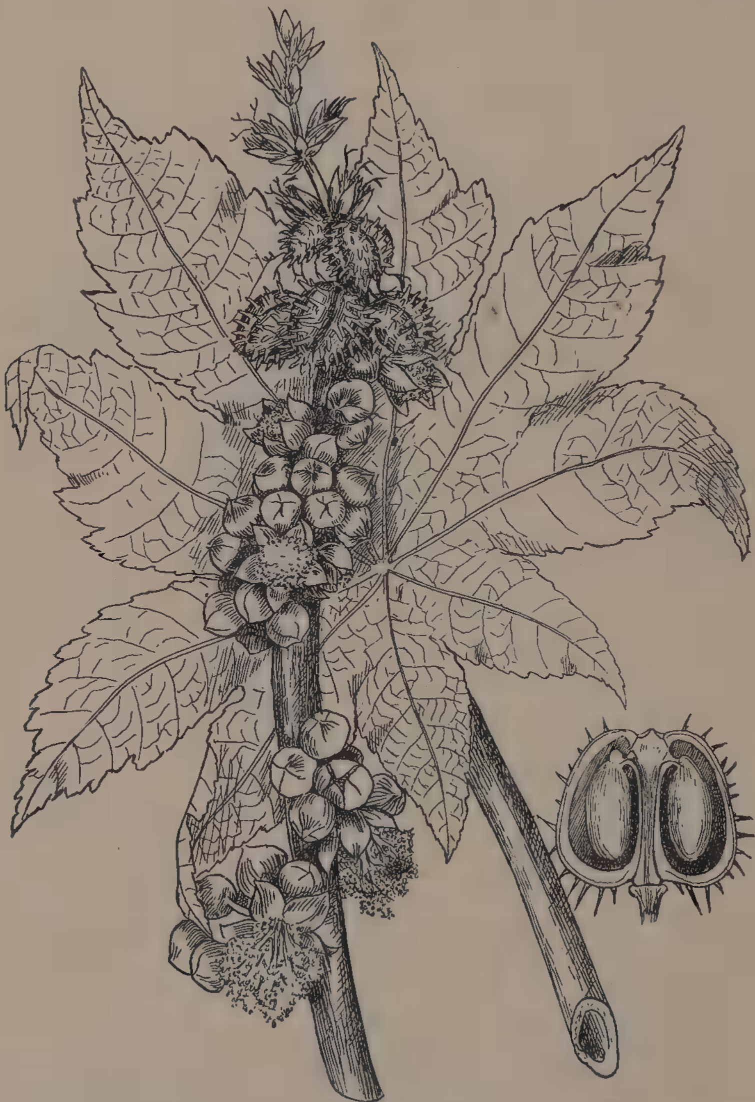


FIG. 194.—*Ricinus communis*—Flowering stem, leaf, and section of fruit.

side; at one end is a yellowish caruncle from which runs an obscure, longitudinal ridge (raphé) to the opposite end; externally smooth, of a **glossy grayish color, mottled with reddish-brown** from the removal, in places, of the thin, white pellicle investing the black, brittle testa. Embryo and albumen very oily; cotyledons broad and veined. Inodorous; taste sweetish, then acrid. They contain a **fixed oil,** 45 to 50 per cent. (Oleum Ricini, U. S.), ricinin, and a poisonous principle, ricin. They are more active, weight for weight, than the oil.

491 a. **OLEUM RICINI.**—CASTOR OIL. The commercial fixed oil is extracted in several ways, the finest product being yielded by the process known as cold expression. It is a thick, viscid, transparent liquid with a feeble odor, and a mild, somewhat acrid and nauseous taste, soluble in its own weight of strong alcohol. On standing, it becomes thicker, and deposits a white, crystalline substance. Ricinolein

FIG. 195.—*Croton tiglium*—Flowering branch; flower (enlarged); seed, entire and in section (enlarged).

(the glyceride of ricinoleic acid) constitutes the bulk of castor oil, with small quantities of palmitin, stearin, myristin, and an acrid principle. A mild and efficient **cathartic.** Dose: $\frac{1}{4}$ to 2 fl. oz. (8 to 60 Cc.). Employed in making flexible collodion, 3 per cent.

492. **TIGLIUM.**—CROTON SEED. The seed of **Cro'ton tig'lium** Linné, a small tree indigenous to China, but extensively cultivated in India. The fruit is a smooth capsule about the size of a large hazelnut, 3-celled, each contain-

ing a single seed. **The seeds** are from 12 to 15 mm. (½ to ⅗ in.) long, oval-oblong, resembling castor-oil seeds in shape but somewhat larger, and **quadrangular,** and with the caruncle usually absent; the testa is soft, dull yellowish-brown, generally partially, but occasionally wholly, rubbed off from the black tegmen by friction, giving the seeds a **mottled** or **nearly black** appearance; albumen and embryo yellowish-brown; odor feeble; taste acrid. It yields about 50 to 60 per cent. of an **acrid fixed oil** (Oleum Tiglii, U. S.).

492 a. **OLEUM TIGLII,** U. S.—CROTON OIL. A rather viscid, pale yellowish to brown fixed oil, with a peculiar, faint odor, and an exceedingly hot, acrid taste, continuing in the mouth for several hours. It consists of the glycerides of lauric, myristic, palmitic, stearic, formic, acetic, crotinic, $C_4H_6O_2$, isobutyric, isovalerianic, and tiglinic, $C_5H_8O_2$, acids. The vesicating properties are due to a croton resin. Purgative principle is insoluble in alcohol. **Drastic purgative,** capable of causing death in excessive doses. Dose: ½ to 2 ♏ (0.0324 to 0.13 Cc.), in emulsion. Applied externally in liniment, it is a powerful rubefacient.

493. **CURCAS.**—PURGING NUTS. The seeds of **Cur'cas pur'gans** Adanson. *Habitat:* Brazil, West Indies, and Africa. They resemble croton seeds, but have a dull black, fissured surface and are somewhat milder in action. The purgative principle is ricinoleic acid; they also contain about 40 per cent. of an acrid, colorless fixed oil.

494. **KAMALA.**—ROTTLERA. The glands and hairs from the capsule of **Mallo'tus philippinen'sis** Mueller Arg. Official U. S. P. 1890. A brick-red, mobile, finely granular powder, almost odorless and tasteless, with a gritty feeling between the teeth; excessive grittiness, however, indicates a probable adulteration with earthy matter, which may be detected by floating it in water. It is inflammable, flashing up like gunpowder, with a red flame. Under the microscope the powder is seen to consist of depressed globular, transparent sacs, containing numerous red, hood-shaped vesicles, and mixed with colorless hairs. Almost insoluble in water; soluble in alcohol, imparting a deep red color to the solution, from which water throws down a resinous precipitate. *Flemingia rhodocarpa* Baker or Warrus, a leguminous plant indigenous to Eastern Africa, has been employed as substitute. The powder is coarser than kamala, is deep purple, in a water-bath becomes black, and has a slight odor. The glands are cylindrical or subconical. *Constituents:* Resins (supposed to be the active principle) and resinous coloring matters, one of which has been isolated and termed **rottlerin,** $C_{22}H_{20}O_6$. Vermifuge. Dose: 1 to 2 dr. (4 to 8 Gm.).

Preparation of Rottlerin.—Obtained by exhausting with ether or carbon disulphide, evaporating and crystallizing; occurs in yellowish needles; soluble in hot alcohol, ether, benzene, or carbon disulphide; changes on exposure.

URTICACEÆ.—Nettle Family.

A large and very diversified family, consisting of herbs, shrubs, or trees, sometimes with a milky juice yielding caoutchouc; some species have a bark which yields mucilage; the nettleworts are remarkable for the caustic secretion of their glandular stinging-hairs; the juice of the hempworts (suborder Cannabineæ) is bitter and narcotic.

Synopsis of Drugs from the Urticaceæ.

A. *Bark.*
ULMUS, 495.
B. *Strobiles.*
HUMULUS, 496.
C *Glands.*
LUPULINUM, 497.
D. *Herb.*
CANNABIS INDICA, 498.
Urtica, 499.
E. *Seed.*
Cannabis Semen, 498 a.
F. *Fixed Oil.*
Oleum Cannabis, 498 b.
G. *Fruits.*
FICUS, 500.
Morus, 501.

495. ULMUS.—Elm.

SLIPPERY ELM BARK. *Ger.* ULMENRINDE.

The dried bark of **Ul′mus ful′va** Michaux (Fam. Ulmaceæ—U. S. P. 1900), deprived of its periderm.

Botanical Characteristics.—A tree 40 to 60 feet high. *Leaves* ovate-oblong, taper-pointed, doubly serrate, very rough above. *Flowers* nearly sessile, in lateral clusters, purplish or brownish. *Fruit* a 1-celled, 1-seeded samara, winged all around.

Fig. 196.—*Ulmus fulva*—Branch.

Habitat.—North America, north of the Carolinas and east of Nebraska.

Description of Drug.—Various sized **flat pieces** about 4 mm. ($\frac{1}{6}$ in.)

thick, **deprived of cork,** of a uniformly pale brownish-white color, the finely ridged inner surface with a slight reddish tinge; good specimens are **tough and flexible,** capable of being bent double. The texture consists of soft parenchymatous tissue with tangentially arranged bast fibers and numerous medullary rays, giving to a cross-section of the bark a delicately checkered appearance. **Odor** agreeable, resembling fenugreek. Taste highly mucilaginous. It yields a fawn-colored powder which is often adulterated with starch. European elm bark, from *U. campestris* and *U. effusa,* cinnamon-colored,

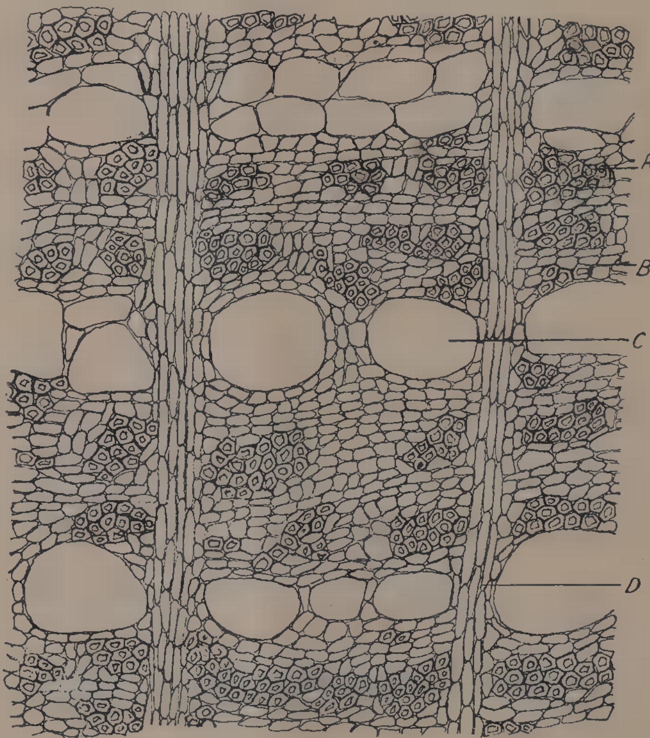


FIG. 197.—Ulmus—Cross-section of bark. *A*. Bast fibers. *B*. Parenchymatous tissue. *C*. Mucilage ducts. *D*. Medullary rays.

nearly inodorous, mucilaginous, but has a bitterish and astringent taste, owing to the presence of a little tannin. A few nearly spherical starch grains (0.005 to 0.01 μ in diameter) are sometimes present.

CONSTITUENTS.—A large quantity of mucilage (capable of precipitation with alcohol and lead acetate), and some tannin.

ACTION AND USES.—**Demulcent**—externally as an emollient application, in poultice. Dose: 2 dr. (8 Gm.) or more.

OFFICIAL PREPARATION.

Mucilago Ulmi (6 Gm. digested in 100 Gm. of water).

496. HUMULUS.—Hops.

HOPS. *Ger.* HOPFEN.

The strobiles of **Hu'mulus lu'pulus** Linné, carefully dried—bearing the whole of their natural glandular coating (Fam. Moraceæ, U. S. P. 1900).

BOTANICAL CHARACTERISTICS.—Rough, climbing perennial. *Leaves* palmately 3- to 7-lobed, roughish, ovate. *Flowers* diœcious, the fertile flowers forming a strobile in fruit; *calyx*, *akene*, etc., thickly studded with yellowish, resinous grains, which give the bitterness and aroma to the hops.

HABITAT.—North Temperate Zone.

DESCRIPTION OF DRUG.—**Strobile** about 30 mm. ($1\frac{1}{5}$ in.) long, **cone-shaped,** consisting of numerous membranous, greenish-yellow scales attached to a thin, undulating, hairy axis; the scales are oval, leaf-like, translucent, showing delicate veins, and surround a subglobular akene; there is also, covering the surface of the scales at the base and adhering to the zigzag axis, **small yellow grains of lupulin,** upon which the value of hops depends. Odor strong, peculiar, somewhat narcotic; taste bitter, aromatic, slightly astringent.

CONSTITUENTS.—**Lupulin** (Lupulinum, U. S.), volatile oil (0.08 per cent.), resin, choline, and tannin.

ACTION AND USES.—Tonic, anodyne, and slightly narcotic. Dose: $\frac{1}{2}$ to 5 dr. (2 to 20 Gm.), in infusion or tincture. Externally as an anodyne or sedative in fomentation or poultice.

OFFICIAL PREPARATION.

Tinctura Humuli (20 per cent., 1890), . . Dose: 1 to 3 fl. dr. (4 to 12 Cc.).

497. **LUPULINUM,** U. S.—LUPULIN. The granular powder separated from humulus, bright yellow, becoming yellowish-brown with age; mixed with minute scale particles; resinous; **odor** peculiar, aromatic, like hops, but stronger; taste bitter. Under the microscope each gland is seen to be composed of two reticulated hemispheres, one narrow and one round; the narrow one collapses on drying, giving to the granule a hood-shaped appearance. They are filled with an oleoresin, the volatile oil of which contains a trace of valerianic acid, and valerol, which passes into valerianic acid when kept a long time, causing the valerian-like odor of old hops—lupamaric acid, $C_{35}H_{35}O_4$.

ACTION AND USES.—Same as hops. Dose: 6 to 15 gr. (0.4 to 0.1 Gm.), in capsules or pills, the latter of which may be made by simply rubbing the powder with warm water until it becomes adhesive.

OFFICIAL PREPARATIONS.

Fluidextractum Lupulini, ... Dose: 10 to 30 ♍ (0.6 to 2 Cc.).
Oleoresina Lupulini, ... 3 to 6 ♍ (0.2 to 0.4 Cc.).

498. CANNABIS INDICA.—Indian Cannabis.

INDIAN HEMP. HEMP. *Ger*. INDISCHER HANF.

The dried flowering tops of the pistillate plant of **Can'nabis sati'va** Linné (Fam. Moraceæ, U. S. P. 1900), growing in the East Indies. The ovules unfertilized and carrying the whole amount of its natural resin.

Botanical Characteristics.—*Stem* 4 to 8 feet high, annual, tall, and roughish, the inner bark consisting of tough fibers. *Leaves* palmately 5- to 7-divided, the *leaflets* coarsely serrate. *Flowers* diœcious, green, in compound, axillary racemes or panicles. *Akene* globose, crustaceous.

Fig. 198.—*Cannabis indica*—Branch.

Source.—The plant is indigenous to Asia, from India northward to Western China and Caspian Sea. Its cultivation has extended to Central and Southern Europe, Russia, Brazil, and the Western United States—in fact, it may be said to grow in all civilized countries on the globe.

Description of Drug.—Cannabis indica occurs in commerce as bundles of the flowering tops; the branches, digitate leaves, and the numerous flower-bracts are more or less compressed, and **agglutinated to-**

gether with a resinous exudation; color brownish-green; odor peculiar, narcotic; taste bitterish, somewhat acrid. It is sold in Indian bazaars for smoking purposes as "gunjah." The leaves, small stalks, and capsules, dried separately and mixed with aromatics and fruits, form the Arabian confection, "hashish, bhang, or siddhi." "Churrus" is a brown, earthy-looking resin, brushed off from the plants by leather-clad men running through the field.

Cannabis americana, the plant grown in various parts of the United States, acts similarly to the official plant, but is less powerful.

Powder.—Dull greenish. Characteristic elements: Parenchyma with small aggregate calcium oxalate crystals, about 20 μ in diam.; sclerenchyma with bast fibers, long, thin-walled, with few simple pores; ducts frequently spiral; trichomes one-celled, sometimes with crystoliths, one or many celled, heads 8 to 16 celled; pollen, spheroidal (25 to 35 μ in diam.); oil and resin in fragments.

CONSTITUENTS.—The resin and a yellow, aromatic volatile oil, $C_{10}H_{16}$, are its most important constituents. The former, **cannabin** (15 to 20 per cent.), is a brown, amorphous powder, soluble in absolute alcohol (but not in cold alcohol of 89 to 90 per cent.), from which solution it is thrown down as a white precipitate by water; it is very potent, $\frac{2}{3}$ of a grain acting as a powerful narcotic; it comes into the market as cannabin tannate; choline, $C_5H_{15}NO_2$, syrupy, soluble in alcohol and water, very sensitive to Mayer's reagent, yielding a yellow, crystalline precipitate, is probably the same as the so-called alkaloid, "tetano-cannabinine."

Cannabinol.—This principle has been obtained by Wood, Spivey, and Esterfield from the exudate of cannabis indica (*charas*). Several different fractional distillates from the ethereal extract of this exudate were obtained. Among these distillates is *cannabinol*, $C_{18}H_{24}O_2$, boiling at 265° C. It is oleaginous and has a red color. This they have found to largely represent the active principle. A condensed account of the pharmacology of cannabis indica, as contributed by Dr. C. R. Marshall, may be found in "Western Druggist," 1899, pp. 163–166.

Preparation of Cannabin.—Treat drug with water made alkaline with Na_2CO_3; exhaust dry residue with alcohol; add milk of lime; precipitate with H_2SO_4; treat filtrate with animal charcoal. From the resulting liquid, concentrated, cannabin is precipitated by water.

ACTION AND USES.—**Powerful narcotic.** The primary effect of the drug is that of exhilaration, intoxication, etc. This is followed by depression, drowsiness, and stupor. It has some advantages over opium, it is claimed, in that it is not constipating, and interferes less with digestion; it is more acceptable in certain morbid states of the system and nervous disquietude. Dose: 3 to 5 gr. (0.2 to 0.3 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Cannabis Indicæ (10 per cent.), ...Dose:	5 to 20 ♏ (0.3 to 1.3 Cc.).
Fluidextractum Cannabis Indicæ,....	2 to 3 ♏ (0.13 to 0.2 Cc.).
Extractum Cannabis Indicæ,........	$\frac{1}{8}$ to 1 gr. (0.0081 to 0.0650 Gm.).

498 a. **CANNABIS SEMEN.**—Hemp Seed. These have been used in the form of emulsion as demulcent and anodyne, depending upon the fixed oil which they contain. They are mostly used as a bird-seed, however, and for the extraction of the fixed oil.

498 b. **OLEUM CANNABIS.**—Oil of Hemp. A greenish fixed oil, becoming lighter and brownish on exposure; odor hemp like; taste mild. Used as a demulcent and protective. Neither it nor the seed are thought to have any narcotic action.

499. **URTICA.**—Nettle. Stinging Nettle. The herb of **Urti'ca dio'ica** Linné. *Habitat:* United States and Europe. Tonic, astringent, and a valuable diuretic. As an astringent it is chiefly used in uterine hemorrhages. Dose: 20 to 40 gr. (1.3 to 2.6 Gm.).

Fig. 199.—*Ficus carica*—Branch and fruit.

500. FICUS.—Fig.

FIG. *Ger.* FEIGEN.

The partially dried fruit of **Fi'cus car'ica** Linné (Fam. Moraceæ, U. S. P. 1900).

Botanical Characteristics.—A small tree with palmately-lobed, cordate *leaves*. *Flowers* monœcious, inclosed within a pear-shaped receptacle which converges so as to leave only a small orifice at the apex; *style* single; *stigmas* 2.

HABITAT.—Levant; cultivated extensively in the Mediterranean Basin and subtropical regions.

COLLECTION.—Figs are either left on the tree to dry or are dried after being gathered by artificial heat or the heat of the sun, and in this condition are called "natural figs," or they are rendered pliant by pulling and kneading. They are then packed in boxes or drums and known as "pulled figs." The largest and best are those of Smyrna and Turkey, the best Smyrna being known as "Eleme figs." The largest amount is imported from Asiatic Turkey, and the remainder from Spain, Portugal, and other countries.

DESCRIPTION OF DRUG.—Figs come into market compressed, and covered with an efflorescence of sugar which melts in warm weather and makes them soft and moist. They are yellowish or brownish, somewhat translucent, and consist mostly of a sweet, viscid pulp, in the center of which are numerous small, yellow ovaries, or akenes, popularly regarded as seeds; odor peculiar; taste sweet, mucilaginous. When soaked in water they may be opened out to their original pear-shaped form, showing the short stalk, or its scar, at the base or pointed end, and scales at the large end surrounding an orifice near which the staminate flowers were situated; the numerous akenes, or ovaries, of the pistillate flowers cover the walls of the hollow interior.

CONSTITUENTS.—Grape sugar (60 to 70 per cent.), gum, fat, and salts.

ACTION AND USES.—Nutrient, laxative, and demulcent. Their principal use medicinally is as a laxative diet in constipation, freely given, which action in dried figs is mainly due to the indigestibility of the seeds and tough skin. Dose: 4 dr. (15 Gm.).

OFFICIAL PREPARATION.

Confectio Sennæ (12 per cent.), ...Dose: 1 to 3 dr. (4 to 12 Gm.).

501. **MORUS.**—MULBERRY. The fruit of **Mo'rus ru'bra, M. nigra,** and **M. alba** Linné, indigenous trees. Dense, cylindrical spikes of the small fruit, differing in size, shape, and color in the different species. They are all used in the fresh state as a refrigerant.

JUGLANDACEÆ.—Walnut Family.

A small family of trees with monœcious flowers and the fruit a nut.

502. **JUGLANS.**—BUTTERNUT. The root-bark of **Jug'lans cine'rea** Linné, collected in autumn. Off. U. S. P. 1890. Corky layer very thin, smooth, grayish, easily removed, leaving a smooth, deep-brown surface; inner surface pure white when the bark is first removed from the tree, but changes to deep brown on exposure. In the market it is found in flat or curved pieces about $\frac{1}{5}$ of an inch (5 mm.) thick, the outer surface dark gray and nearly smooth, or, deprived of the soft cork, deep brown, the inner surface striate. Fracture short, whitish-and-brown checkered; medullary rays somewhat diagonal; odor feeble; taste bitter, somewhat acrid. The

leaves and bark of *Juglans nigra* (black walnut) have been used as an alterative and deobstruent, and the bark of *Carya alba* (shellbark hickory) as a tonic and antiperiodic. The kernels of the nuts of all these trees yield about 25 per cent. of a pale greenish fixed oil (Oleum Juglandis, or nut oil), used as a demulcent. *Constituents:* Bitter oily extractive, in large proportion juglandic acid, $C_{10}H_6O_8$, tannin (?), two other acids, one of them volatile, with potassium, sodium, and other salts. A mild cathartic, especially valuable in habitual constipation. It was much used in the army during the Revolutionary War. Dose: 1 to 2 dr. (4 to 8 Gm.).

MYRICACEÆ.—Sweet-gale Family.

503. **MYRICA.**—Bayberry Bark. Wax Myrtle. The bark of **Myri'ca ceri'fera** Linné, an indigenous plant growing on seashores, the fruit of which is covered with a layer of white vegetable wax. This bark is occasionally used in medicine as a tonic, and as an astringent gargle in sore throat, etc. Dose of fl'ext.: 15 to 30 ♏ (1 to 2 Cc.).

504. **COMPTONIA.**—Sweet Fern. The leaves of **Compto'nia asplenifo'lia** Aiton, an indigenous herb. They are linear-lanceolate, with deep, alternate, rounded lobes, and have a spicy odor, especially when rubbed. Stimulant and astringent. Dose: 15 to 30 gr. (1 to 2 Gm.).

CUPULIFERÆ.—Oak Family.

An important order on account of its valuable wood. It is characterized by alternate *leaves* and monœcious *flowers*, the *sterile* ones in catkins, the *fertile* in clusters or spikes, and the *fruit* a 1-seeded nut, with or without a woody, scaly involucre (cupule).

Synopsis of Drugs from the Cupuliferæ.

A. *Bark.*	B. *Excrescence.*	C. *Leaves.*
QUERCUS, 505.	**GALLA,** 508.	Castanea, 509.
Alnus, 506.	**ACIDUM TANNICUM,** 508 a.	**OLEUM BETULÆ VOLATILE,** 510.
Fagus, 507.	**ACIDUM GALLICUM,** 508 b.	D. *Heart-wood.*
	PYROGALLOL, 508 c.	Ostrya, 511.

505. QUERCUS.—White Oak.

WHITE OAK. *Ger.* EICHENRINDE.

The bark of **Quer'cus al'ba** Linné, collected from trunk or branches ten to twenty-five years of age and deprived of the periderm.

Botanical Characteristics.—A large tree 100 to 120 feet high, with pale bark. *Leaves* smooth, pale or glaucous beneath, bright green above, obovate-oblong, pinnately 3- to 9-lobed. *Stigma* sessile. *Cupule* saucer-shaped, tuberculated, much shorter than the ovoid *acorn.*

Habitat.—North America, westward to Minnesota, Kansas, and Mississippi.

Description of Drug.—Flat pieces about 6 mm. ($\frac{1}{4}$ in.) thick, deprived of the thick, corky layer; pale brown; coarsely fibrous; inner sur-

face traversed by prominent longitudinal ridges; fracture coarse, fibrous (the tissue contains groups of stone cells and crystals of calcium oxalate); odor faintly tan-like; taste very astringent. It is usually found in the shops as a coarse, fibrous powder.

Powder.—Pale brown. Characteristic elements: Parenchyma of cortex, rather thin-walled, pale brownish rosy hue, some with brown resin or irregular brownish-yellow tannin masses; calcium oxalate, aggregate or prisms (10 to

FIG. 200.—*Quercus alba*—Branch.

20 μ in diam.); sclerenchyma with stone cells (25 to 40 μ in diam.), thick-walled; bast fibers 15 to 30 μ thick, long, rather large, thick-walled; crystal fibers with aggregate and prismatic crystals of calcium oxalate (10 to 20 μ in diam.); cork cells, pentagonal or hexagonal (20 to 30 μ in diam.).

CONSTITUENTS.—**Quercitannic acid** 6 to 11 per cent., a coloring matter, a bitter principle (quercin), sugar (quercite), resin, etc. The active principles are soluble in water and alcohol. The amount of tannin varies with the species, the part of the tree, and the season of the

year when gathered; the young bark contains a greater proportion than the old.

Quercitannic Acid.—Two forms of this principle exist, according to Lowe—one soluble in water, of the formula $C_{28}H_{28}O_{14}$, and the other scarcely soluble, $C_{28}H_{24}O_{12}$. Both are changed by the loss of water into *oak red*, $C_{28}H_{22}O_{11}$. Neither is a glucoside.

Quercitron.—Under this name large quantities of black oak (*Quercus tinctoria*) bark deprived of its epidermis and reduced to a coarse powder are sent from the United States to Europe as a dye. The coloring principle is called quercitron, $C_{36}H_{38}O_{30}$. This glucoside splits up by hydrolysis into quercetin and isodulcite, or rhammose, $C_6H_{12}O_5(C_5H_9O_5CH_3)$. Quercetron (*Xantho rhamnin*) forms yellowish crystals, odorless and tasteless, but in hot aqueous or alcoholic solution has a bitter taste.

Preparation of Quercin.—Boil bark in acidulated (H_2SO_4) water; add milk of lime to neutralize; filter; add K_2CO_3. Yellow needles slowly form on evaporation of alcoholic solution of above precipitate.

ACTION AND USES.—**Astringent** and tonic, generally used externally in infusion or decoction as an astringent and tonic bath, injection, etc. Dose: 15 to 60 gr. (1 to 4 Gm.). **Fluidextractum Quercus,** U. S.

506. **ALNUS SERRULATA** Willdenow.—TAG ALDER. *Habitat:* North America. (Bark.) Tonic, astringent, and alterative. Dose: 30 to 60 gr. (2 to 4 Gm.).

507. **FAGUS FERRUGINEA** Aiton.—AMERICAN BEECH. (Bark and leaves.) Astringent and slightly tonic.

508. GALLA.—NUTGALL.

GALLS. *Ger.* GALLÄPFEL.

An excrescence produced on **Quer'cus lusitan'ica** Lamarck by the punctures and deposited ova of *Cynips gallæ tinctoriæ* (Fig. 201) Olivier (class, Insecta; order, Hymenoptera).

BOTANICAL CHARACTERISTICS.— A shrub or small tree 6 to 8 feet high. *Leaves* short-petiolate, obovate-oblong, obtusely toothed, oblique at base. *Acorn* solitary, obtuse, two or three times the length of the cup.

HABITAT.—Levant.

DESCRIPTION OF DRUG.—**Hard, heavy, subglobular,** from the size of a pea to that of a large cherry, contracted below into a **short stipe** and covered above with a few or many **prom nent warts** (tuberculated) between which the surface is smooth. Externally dark bluish or lead color, frequently with a greenish tinge, often with a circular hole near the middle upper part, communicating with the central cavity. They break with a flinty fracture, showing a whitish or brownish interior, with often a **central cavity,** lined with a thin,

hard shell, which contains the insect in all stages of development, or the pulverulent remains of the developed insect mixed with partly eaten fragments of the starchy parenchyma. Odorless; very astringent.

STRUCTURE.—The tissue is chiefly parenchyma, loaded with tannin and

FIG. 201.—*Quercus lusitanica*—Branch and nutgall.

chlorophyll; the cavity lining is composed of stone cells containing calcium oxalate crystals; within this cavity, if not eaten out, is a starchy parenchyma.

VARIETIES.—Most of the oaks are occasionally affected as the above species, the resulting excrescence, known as *galls*, developing a tannin

which may be employed for various practical purposes. The Aleppo or Syrian, dark colored and heavy (although the designation Aleppo is not wholly applicable to the official galls—"Galla"), are the products of different parts of Asiatic Turkey; still the name is applied to this variety. *Smyrna* galls, grayish-olive color, intermixed with white galls. *Sorian*, size of a pea, blackish. *Japanese* and *Chinese*, from *Rhus simulata*, ½ to 2 inches long, ovate, very irregular, tubercular, grayish downy, inclosing the remnants of numerous insects. The Chinese make use of this product in dyeing and as a medicine.

Powder.—Brownish-gray. The microscopic elements consist of: One-celled trichomes; thin-walled parenchyma; few starch granules and spiral ducts.

CONSTITUENTS.—Tannin 65 to 77 per cent. (gallotannic acid), chemically known as digallic acid, $C_{14}H_{10}O_9$. It is a yellowish-white amorphous substance, insoluble in absolute ether, chloroform, benzol, benzin, and carbon disulphide, soluble in glycerine, alcohol, and water; precipitated blue-black by ferric salts, and white by gelatin. It appears to exist, in part at least, as a glucoside and digallic acid. Digallic acid may be considered as an anhydride of gallic acid, $C_7H_6O_5$, formed from two molecules of the latter by elimination of one molecule of water. Gallic acid also exists in galls. It is precipitated blue-black by ferric salts, the color disappearing on boiling, and is not affected by gelatin when gum is absent.

Preparation of Tannic Acid.—Powdered nutgall is exposed to damp atmosphere for twenty-four hours, then made into paste with washed ether. Allow to stand six hours, then express in canvas cloth between tinned plates. After powdering the pressed cake, again make into paste with washed ether. Repeat the former process and allow the mixed liquid to evaporate spontaneously.

ACTION AND USES.—Galls are strongly **astringent,** but in the crude form are only used locally. From them are extracted tannic and gallic acids. Dose: 8 gr. (0.6 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Gallæ (20 per cent.), ...	Dose: ½ to 2 fl. dr. (2 to 8 Cc.).
Unguentum Gallæ (20 per cent.).	
Glyceritum Acidi Tannici (20 per cent. tannic acid).	
Unguentum Acidi Tannici (20 per cent. tannic acid).	
Collodium Stypticum (20 per cent. tannic acid)	
Trochisci Acidi Tannici (about 1 gr. in each troche), ...	1 to 2 troches.

508 a. **ACIDUM GALLICUM,** U. S.—GALLIC ACID. Usually prepared from tannic acid. Also prepared by exposing moistened powdered nutgalls to the action of the air for a month or more; a peculiar

fermentation sets in which converts the tannic acid into gallic acid; this is extracted by expression and purified by filtration and crystallization. It is in **light, silky, acicular needles,** colorless when pure, but as usually seen in the shops, of a more or less **pale brownish color;** inodorous; taste sourish and astringent. **It differs from tannic acid** in its sparing solubility in cold water, and in not precipitating gelatin or alkaloids from their solutions. It is less astringent than tannic acid, and inferior to it in all respects except where the astringent effect must be reached through the medium of the general circulation. Dose: 5 to 30 gr. (0.3 to 2 Gm.).

508 **b. PYROGALLOL,** U. S.—Pyrogallic Acid. A triatomic phenol, $C_6H_3(OH)_3$, obtained chiefly by the dry distillation of gallic acid. It is in light, white, shining laminæ, or in fine needles, becoming gray or darker when exposed to the air or light, and should therefore be kept in amber-colored bottles; inodorous; astringent. Soluble in water and alcohol. **Used exclusively externally** in the form of ointments, in lupus, psoriasis, and other **skin diseases.** Its absorption through abrasions in the skin has caused death by general poisoning.

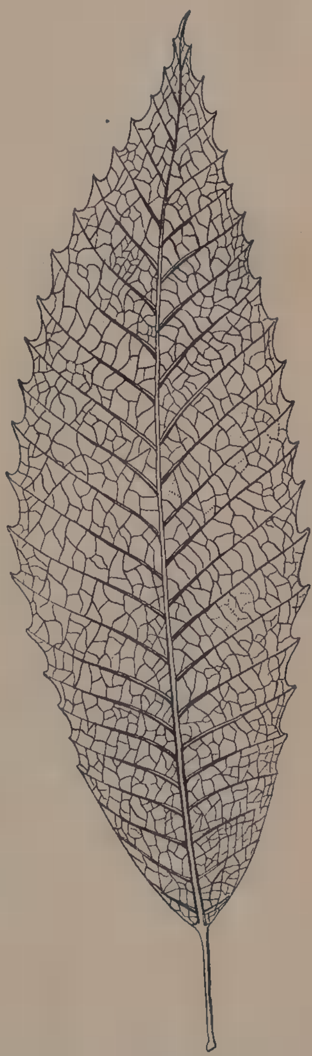


Fig. 202.—Chestnut leaf, natural size.

509. **CASTANEA.**—Chestnut. The leaves of **Castan'ea denta'ta** Sudworth, collected in September or October while yet green. Off. U. S. P. 1890. Oblong, elliptical, from 150 to 250 mm. (6 to 10 in.) long, and about 50 mm. (2 in.) broad, with a sharply pointed apex and a short petiole; margin somewhat unequally, but strongly, repand-dentate, with prominent parallel veins beneath each tooth (feather-veined); texture firm, flexible; odor slight; taste somewhat astringent. *Constituents:* Tannic acid about 9 per cent., gum, albumen, salts, and traces of resin and fats. Tonic and astringent, used almost exclusively in whooping-cough in the form of infusion or fl'ext. Dose: ½ to 2 dr. (2 to 8 Gm.).

Fluidextractum Castaneæ, U. S. P. 1890, Dose: ½ to 2 fl. dr. (2 to 8 Cc.).

510. OLEUM BETULÆ.—Volatile Oil of Betula.

OIL OF SWEET BIRCH.

A volatile oil distilled from the bark of **Betula lenta** Linné (Fam. Betulaceæ, U. S. P. 1900).

Botanical Characteristics.—A tree often exceeding 60 feet in height, with a diameter of 2 or 3 feet. The trunk is invested with a dark brown or reddish bark, separating in thin layers. Remarkable for its agreeable fragrance and flavor. *Leaves* cordate, ovate-acuminate, acutely, finely, and doubly serrate, veined beneath. *Flowers* monœcious, *sterile* catkins 2 or 3 inches long, *fertile* much shorter and thicker; *petals* hairy; wood reddish, strong, compact.

Description.—This oil is **identical with methyl salicylate,** $CH_3C_7H_6O_3$, and nearly identical with **oil of wintergreen** (330 a). Its specific gravity is 1.18. In fact, is one of the sources of commercial oil of wintergreen. Dose: 5 to 30 ♏ (0.3 to 2 Cc.). It should be kept in well-stoppered bottles, protected from the light.

511. **OSTRYA VIRGINICA.**—Iron-wood. Hop-hornbeam. The wood has some reputation as an antiperiodic, tonic, etc. The fl'ext. is used in malaria, in doses of ½ to 1 fl. dr. (2 to 4 Cc.).

SALICACEÆ.—Willow Family.

Diœcious trees or shrubs with both kinds of flowers in catkins; fruit bearing numerous seeds furnished with long, silky down.

512. **SALIX.**—Willow. The bark of **Sa'lix al'ba** Linné, and of other species of Salix. *Habitat:* Europe; naturalized in North America. The best bark is that collected from the older branches, coming in thin fragments or quills, the thin brownish or yellowish periderm of which overlays a greenish parenchymatous layer. The bark from the trunk is deprived of the outer layer, pale cinnamon-brown, exfoliating; fibrous. Inodorous; taste bitter and astringent. Two varieties—white willow and purple willow, *S. purpurea* (see below).

Constituents.—Tannin about 12 per cent., most abundant in the white willow, and a bitter neutral principle, **salicin,** which is the active glucosidal constituent, occurring and coming into market in silky, shining, white needles or grains; it exists most abundantly in the purple willow, but may be extracted from various other species and from various species of Populus, where it is combined with populin (benzoyl salicin). The degree of bitterness in the barks is probably the best criterion of the value of the several species.

512 a. **SALICINUM.**—It occurs in white, shining, bitter crystals, soluble in 28 parts of water and 68 parts of alcohol. Boiled with sulphuric acid it is converted into saligenin or saligenol, $C_7H_8O_2$, and glucose, according to the following formula: $C_{13}H_{18}O_7 + HO = (C_6H_4)(OH)CH_2OH + C_6H_{12}O_6$. By oxidation with potassium bichromate and sulphuric acid, salicylic aldehyde, $C_6H_4OH.COH$, is formed, having the fragrant odor of the oil of meadowsweet (*Spiræa ulmaris*) and of heliotrope. Tonic, astringent, **febrifuge.** Dose: 15 to 60 gr. (1 to 4 Gm.). The bark itself

is rarely employed, however, salicin being used instead in doses of 10 to 30 gr. (0.6 to 2 Gm.).

Preparation of Salicin.—Obtained by adding lead subacetate to a decoction of the bark, precipitating the excess of lead with H_2S. Evaporate liquid. Add, near the end of the process, sufficient quantity of animal charcoal to decolorize; filter the liquid while hot. Upon cooling, salicin will deposit in crystalline form.

513. **POPULUS.**—White Poplar. American Aspen. The bark of **Pop′ulus tremuloi′des** Michaux. Tonic and febrifuge. Its active principle, populin, is analogous to the salicin of salix (510). Dose of fl'ext.: 30 to 60 ♍ (2 to 4 Cc.).

Fig. 203.—*Salix alba*—Branch.

514. **POPULUS BALSAMIFERA.**—Balm of Gilead Buds. The buds of **Pop′ulus balsamif′era** Linné, variety **candicans** Gray. *Habitat:* Northern North America and Siberia. These buds, as well as those of other species of Populus, are covered with a resinous exudation which is impregnated with a fragrant volatile oil, and is very similar in medicinal action to the turpentine oleoresins. Dose of fl'ext.: 30 to 60 ♍ (2 to 4 Cc.).

GNETACEÆ.

515. **EPHEDRA.**—The herb **Ephe′dra antisyphilit′ica** C. A. Meyer. This plant is a native of Arizona, where it is used in venereal diseases. Dose of fl'ext.: 1 to 2 fl. dr. (4 to 8 Cc.).

CONIFERÆ.—Pine Family.

Trees or shrubs with a resinous juice. The *wood* differs from that of dicotyledons in that it is destitute of ducts, but has instead bordered disks. The

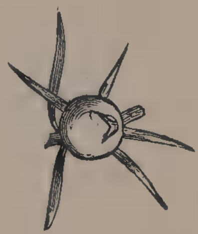


FIG. 204.—Berry (galbulus) and acicular leaves of Juniper.

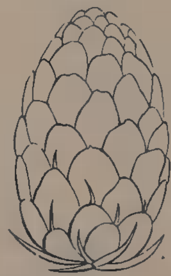


FIG. 205.—Cone of the Larch.

leaves are usually fascicled, and are mostly awl- or needle-shaped. *Fruit* a cone or galbulus.

Synopsis of Drugs from the Coniferæ.

A. *Tops.*
- **SABINA,** 516.
- Juniperus Virginiana, 516 a.
- Thuja, 517.

B. *Fruits.*
- Juniperus, 518.

C. *Barks.*
- Pinus Strobus, 516½.
- Tsuga, 520.
- Larix, 521.

D. *Oleoresins.*
- **TEREBINTHINA,** 522.
- Venice Turpentine, 522 a.
- **TEREBINTHINA CANADENSIS,** 524.
- Pix Canadensis, 525.
- **PIX LIQUIDA,** 523.
- Pix Burgundica, 526.

E. *Volatile Oils.*
- **OLEUM SABINÆ,** 516 b.
- **OLEUM JUNIPERI,** 518 a.
- **OLEUM CADINUM,** 519.
- **OLEUM TEREBINTHINÆ,** 522 b.
- **OLEUM PICIS LIQUIDÆ,** 523 a.
- Oleum Succini, 527 a.

F. *Resins.*
- **RESINA,** 522 c.
- Succinum, 527.
- Dammara, 528.
- Kauri, 529.
- Sandaracca, 530.

516. SABINA.—SABINA.

SAVINE. *Ger.* SEVENBAUM.

The tops of **Junip'erus sabi'na** Linné.

BOTANICAL CHARACTERISTICS.—A small bushy shrub with slender branches. *Leaves* small, opposite, decussate, imbricated. *Fruit* round, bluish-purple.

HABITAT.—Southern Europe and Levant.

DESCRIPTION OF DRUG.—The young and tender green shoots are stripped off in the spring, coming into the market as **short, thin, quadrangular branchlets,** clothed with alternate pairs of minute, opposite, scale-like leaves, appressed (more pointed and divergent in older twigs); each scale has a shallow groove and a conspicuous, depressed oil-gland in the back. The berry-like cone fruit is about the size of a pea, situated on a short, **recurved pedicel,** and covered with a bluish bloom; it is dry, but abounds in essential oil, and contains

from 1 to 4 small, bony seeds. Odor strong, balsamic; taste bitter and acrid. Adulteration: Red cedar tops (516 a).

Powder.—Yellowish-brown. The microscopic elements consist of: Tracheids with bordered pits; parenchyma with numerous stomata; long bast fibers and starch grains.

CONSTITUENTS.—Tannin, resin, gum, etc., and a **volatile oil** (516 b) (2 per cent. in tops, 10 per cent. in berries) having the same composition as oil of turpentine.

ACTION AND USES.—Savine is an irritant, acting especially as a **uterine stimulant;** also diuretic, emmenagogue, and vermifuge. Dose: 5 to 15 gr. (0.3 to 1 Gm.). It is used externally in ointment as a stimulant dressing for bruises.

OFFICIAL PREPARATION.

Extractum Sabinæ Fluidum, ...Dose: 5 to 15 ♏ (0.3 to 1 Cc.).

516 **a. JUNIPERUS VIRGINIANA.**—The tops of the red cedar, or American savine, are often used to adulterate savine, from which they can scarcely be recognized except by difference in taste and smell. The galbulus of the false variety is borne on an **erect pedicel.**

516 **b. OLEUM SABINÆ.**—OIL OF SAVINE. A nearly colorless, sometimes yellow, limpid, volatile oil, having a strong, terebinthinate odor, and a bitterish, intensely acrid taste. It has the same composition as oil of turpentine. Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.).

516½. **PINUS STROBUS** Lin.—WHITE PINE. The inner bark of **Pinus strobus** (Weymouth Pine), from eastern and central North America. In flat pieces about 6 inches long by 3 inches in width and $\frac{1}{24}$ inch in thickness. Bark brittle, fracture irregular, not fibrous, but showing several woody layers. Reddish-brown streaked with gray outside; inner, yellowish blotched with light brown; bland odor; mucilaginous, slightly bitter and astringent taste.

PROPERTIES.—Those of balsamic preparations generally.

USES.—An emollient and expectorant in chronic affections of air-passages. Dose of fluidextract: ½ to 1 fluidrachm (2 to 4 Cc.).

517. **THUJA.**—ARBOR VITÆ. The leafy tops of **Thu'ja occidenta'lis** Linné, a North American evergreen tree. Small flattened twigs having a **scalloped appearance,** due to the flat, lateral leaf-scales, each of which has an oil-gland near its apex; the other leaves folded lengthwise, boat-shaped, mostly glandless; odor balsamic, somewhat terebinthinate; taste pungently aromatic, camphoraceous, and bitter. The medicinal properties of Thuja depend mainly upon a volatile oil. It **resembles savine** in its general action. Dose: 15 to 60 gr. (1 to 4 Gm.), in infusion or fl'ext.

518. **JUNIPERUS.**—JUNIPER BERRIES. The fruit of **Junip'erus commu'nis** Linné, an evergreen shrub or small tree inhabiting the Northern Hemisphere, bearing small cones, the scales of which coalesce in threes, become fleshy, and ripen into the so-called berry. These berries or fruits are globular, about the size of a large pea, with a triangular depression at the top caused by a three-rayed furrow where the scales are united; at the base are a few small scales, remnants of undeveloped whorls; externally of a glossy, purplish-black color, covered with a grayish bloom; they contain a brownish-yellow pulp with oil-glands, in which are imbedded three small, bony, angular seeds, also covered with large oil-glands; odor disagreeably

aromatic, balsamic; taste sweetish, warm, and balsamic, slightly bitter. The Smyrna berry from *J. phœnicea* Linné, yields an oil of greater optical activity.

CONSTITUENTS.—**Volatile oil,** most abundant in the full-grown green berries, being partially converted into resins on ripening, entirely so in the dead-ripe, black berries; also juniperin, sugar (15 to 30 per cent.), wax, fat, proteids, mucilage, etc. Their virtues are extracted by water and alcohol.

ACTION AND USES.—Stimulant and **diuretic,** chiefly used as an adjuvant to more powerful diuretics in dropsical complaints. Dose: 15 to 60 gr. (1 to 4 Gm.), in infusion, water, spirit, etc., the volatile oil, however, obtained from the wood and branches, being principally used. They are largely used in the manufacture of gin, which owes its diuretic properties to them.

518 a. **OLEUM JUNIPERI,** U. S.—OIL OF JUNIPER. A colorless or greenish-yellow volatile oil, with a strong, terebinthinate odor and a hot, acrid taste. Specific gravity 0.850 to 0.865. It consists of pinene, $C_{10}H_{16}$, cadinene, and juniper camphor.

OFFICIAL PREPARATIONS.

Spiritus Juniperi (5 per cent.), ...Dose: 30 ♍ (2 Cc.).
Spiritus Juniperi Co. (0.4 per cent.),...Dose: 2 fldr. (8 Cc.).

519. OLEUM CADINUM.—OIL OF CADE.

JUNIPER TAR OIL. *Ger.* KADE OEL.

An empyreumatic, oily liquid obtained from the heart-wood of **Junip'erus oxyce'drus** Linné, by dry distillation in ovens.

BOTANICAL CHARACTERISTICS.—A tree 10 to 12 feet high, with spreading top and drooping twigs. *Leaves* awl-shaped. *Fruit* globular, reddish-brown, about the size of a filbert.

HABITAT.—Mediterranean Basin.

DESCRIPTION OF DRUG.—A brownish or dark brown, oily liquid, less thick and more mobile than tar, having a tarry but characteristic odor, and an aromatic, bitter, and acrid taste.

ACTION AND USES.—Used mostly externally in the treatment of **cutaneous diseases** and as an insecticide in the form of liniments, ointments, or soaps. Dose: 3 ♏ (0.2 Cc.).

520. **TSUGA CANADENSIS** Carriere.—HEMLOCK SPRUCE. (Bark.) Tonic and astringent. Dose: 15 to 60 gr. (1 to 4 Gm.).

521. **LARIX AMERICANA** Michaux.—TAMARAC. AMERICAN LARCH. (Bark.) Tonic and gently astringent, its chief action being upon mucous membranes. Dose: ½ to 2 dr. (2 to 8 Gm.).

522. TEREBINTHINA.—TURPENTINE.

TURPENTINE. *Ger.* GEMEINER TERPENTIN.

A concrete oleoresin obtained from **Pi'nus palus'tris** Miller (Fam. Pinaceæ, U. S. P. 1900), and other species of Pinus.

BOTANICAL CHARACTERISTICS.—A large tree, 60 to 100 feet, with thin, scaled bark, and hard, very resinous wood. *Leaves* 10 to 15 inches long, in threes,

from long sheaths. *Sterile flowers* rose-purple. *Cones* large, cylindrical or conical-oblong.

SOURCE AND COLLECTION.—Southern United States, particularly North Carolina. The oleoresin is secreted in the sapwood; some of it flows spontaneously, but it is generally obtained by a process called "boxing," as follows: During the winter from one to four excavations, each holding from 4 to 8 pints, are cut into the tree through the sapwood. After a few days the bark above these cavities is removed for about a height of 3 feet, and some of the wood is hacked off, the hacks being in the shape of the letter L. The oleoresin begins to flow about the middle of March, and continues until September or October. The turpentine is removed by means of dippers constructed for the purpose, and then usually distilled. That which flows the first year is considered the best, being termed "virgin dip," and yields about 6 gallons of oil per barrel, and "window-glass rosin"; that of the next and subsequent years is known as "yellow dip," yielding about 4 gallons of oil per barrel, and medium grades of rosin. The turpentine which hardens on the tree is known as "scrapings," and yields about 2 gallons of oil per barrel, leaving a dark resin.

DESCRIPTION OF DRUG.—In yellowish, opaque, tough masses, brittle in the cold, crumbly-crystalline in the interior, of a terebinthinate odor and taste. In warm weather it is a yellowish, viscid semiliquid when fresh, but ultimately, through exposure to the air, becomes perfectly dry and hard.

OFFICIAL PREPARATION.

Ceratum Resinæ Compositus (11.5 per cent.). Employed in ointments and plasters generally.

CONSTITUENTS.—Volatile oil 20 to 30 per cent. (522 b), abietinic anhydride, $C_{44}H_{62}O_4$, in rosin (522 c), the acid of which, abietic acid, $C_{44}H_{64}O_5$, is crystalline, soluble in CS_2, benzol, alcohol, ether, chloroform, glacial acetic acid, and alkalies.

522 a. **Venice Turpentine.**—A yellowish or greenish liquid of honey-like consistence, collected in Switzerland and portions of France from *Larix europæa* De Candolle. Obtained by boring holes into the center of the wood and dipping the liquid out as it accumulates. It received its name from having formerly been almost entirely distributed from the Venetian port. Genuine Venice turpentine is comparatively scarce in the markets to-day, most of it being a factitious brown liquid made by dissolving rosin in oil of turpentine.

A number of other turpentines are obtained from various species of pine, larch, and fir, but hardly any of them enter our markets. The turpentines all agree in their medical properties, and differ only slightly in their physical characteristics, all of them being liquid at

first, thickening through the evaporation and oxidation of their volatile oil, and ultimately solidifying. They melt by heat, and at a high temperature ignite with a white flame attended with dense smoke.

CONSTITUENTS.—**Volatile oil** 20 to 30 per cent., **resin** (abietic anhydride, crystallizing out as abietic acid), a bitter principle, and traces of succinic and acetic acids.

ACTION AND USES.—The turpentines are rarely used internally, the volatile oil, to which the medicinal virtues are due, being used instead. Dose: 15 to 60 gr. (1 to 4 Gm.), in pills. Externally irritant and rubefacient, in ointments and plasters.

522 **b. OLEUM TEREBINTHINÆ,** U. S.—OIL OF TURPENTINE. SPIRITS OF TURPENTINE. A volatile oil distilled from turpentine, the markets of the United States being chiefly supplied by the North Carolina forests. A perfectly limpid, colorless liquid when pure, but generally somewhat colored from resin contained, or from oxidation; odor peculiar, strong, penetrating; taste hot, pungent, somewhat bitter. It is very volatile and inflammable. When purified by distilling with caustic soda, it constitutes the Oleum Terebinthinæ Rectificatum, U. S., which is officially directed to be dispensed when oil of turpentine is required for internal use.

CONSTITUENTS.—Oil of turpentine consists of several terpene hydrocarbons having the formula $C_{10}H_{16}$ (pinene), sp. gr. 0.855–0.870. When exposed to the air, it becomes thick from the oxidation of some of these hydrocarbons into resin. When the rectified oil is treated with nitric acid, large crystals of terpin hydrate (Terpini Hydras, U. S.) separate out, having properties similar to the oil of turpentine. Dose, 2 gr. (0.1 Gm.). The European turpentine oil contains pinene and sylvestrine; it forms with hydrochloric acid a crystalline compound, $C_{10}H_{16}HCl$ (artificial camphor). **Terebenum** is a liquid derived from the oil (consisting chiefly of pinene) by treatment with sulphuric acid, boiling point 156°–160° C. Dose: 8 ♏ (0.5 Cc.).

ACTION AND USES.—Stimulant, diuretic, hemostatic, occasionally diaphoretic; in large doses anthelmintic and cathartic; externally rubefacient, in rheumatism, etc. As a stimulant it is often beneficial in low forms of fever, and, when death is inevitable, to prolong life beyond the natural limit. Dose: 5 to 15 ♏ (0.3 to 1 Cc.) in emulsion.

OFFICIAL PREPARATIONS.

Linimentum Terebinthinæ (35 per cent. with resin cerate).
Oleum Terebinthinæ Rectificatum, ..Dose: 5 to 15 ♏ (0.3 to 1 Cc.)

522 c. **RESINA,** U. S.—Resin. Rosin. Colophony. The residue left after distilling off the volatile oil from turpentine. It has been asserted that **Pinus palustris,** the official species, contains more resin than any other German or American pine. When pure, rosin is of a clear, pellucid, amber color, but the commercial rosin is yellowish-brown, more or less dark, sometimes almost black, the color depending upon its purity and the amount of heat used in its preparation; it breaks with a shining, shallow, conchoidal fracture; odor and taste faintly terebinthinate. White rosin is an opaque variety made by incorporating it with water.

Constituents.—Rosin is the anhydride of abietic acid, $C_{44}H_{62}O_4$, into which acid it may be converted by warming with dilute alcohol.

Action and Uses.—An important ingredient of ointments and plasters, and is said to have the property of preserving them from rancidity by preventing the oxidation of the fatty base.

Official Preparation.

Ceratum Resinæ (35 per cent.).

523. PIX LIQUIDA.—Tar.

TAR. *Ger.* THEER.

Source.—An empyreumatic oleoresin obtained by the destructive distillation of the wood of **Pinus palustris** Miller, and of other species of Pinus. The pine logs are cut into billets, and built up into a stack and covered with earth, as in making charcoal. Slow combustion is started through an opening in the top of the stack, and the resinous matter, as it melts out and collects in a cavity in the center, is drawn off into barrels.

Description.—A resinous, black semiliquid, of an empyreumatic, terebinthinate odor, and a sharp, bitterish, empyreumatic taste. Acid in reaction. Partly soluble in water.

Birch tar, Dagget, or Oleum Rusci, from *Betula alba* Linné, has an odor similar to that of Russian leather.

Constituents.—Tar is a very complex substance, varying with the kind of wood, amount of resins present therein, and the care exercised in its preparation, the chief constituents being an empyreumatic volatile oil, pyrocatechin, acetone, xylol, toluol, cresols (creosote), guaiacol, phenol, etc. The acid reaction which characterizes tar is due to acetic acid, obtained in an impure state as pyroligneous acid by distillation. In the retort is left behind the ordinary solid and fusible pitch of commerce.

Action and Uses.—Stimulant, irritant, insecticide, similar to, but less

irritant than, the turpentines. Dose: 8 to 60 gr. (0.6 to 4 Gm.). The syrup is much used in **pulmonary affections.**

OFFICIAL PREPARATIONS.

Syrupus Picis Liquidæ (0.5 per cent.), . . . Dose: 1 to 4 fl. dr. (4 to 15 Cc.).
Unguentum Picis Liquidæ (50 per cent.).

523 a. **OLEUM PICIS LIQUIDÆ,** U. S.—OIL OF TAR. A volatile oil distilled from tar, the residue left being common pitch, pix nigra. A nearly colorless liquid when first distilled, but soon acquires a dark, reddish-brown color; it has the characteristic odor and taste of tar, which depends upon it for its medicinal properties. Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.), in capsules or emulsion.

524. TEREBINTHINA CANADENSIS.—CANADA TURPENTINE.

CANADA BALSAM. BALSAM OF FIR. *Ger.* CANADISCHER TERPENTIN.

A liquid oleoresin obtained from **A'bies balsam'ea** Linné.

BOTANICAL CHARACTERISTICS.—*Abies balsamea* has solitary leaves, with acuminate apex, and cylindrical cones reflexed in flower.

HABITAT.—Canada, Nova Scotia, Maine, and the mountainous regions further south.

PRODUCTION.—The oleoresin is secreted in small vesicles in the bark, collected by puncturing and allowing the liquid to exude into a vessel having a broad and funnel-like lip. The vesicles contain only from a few minims to 1 fluid drachm.

DESCRIPTION OF DRUG.—A yellowish or faintly greenish, transparent liquid of honey-like consistence, becoming thicker and somewhat darker with age, but always retaining its transparency, and ultimately drying into a transparent mass; it has an agreeable, aromatic, terebinthinate odor, and a bitterish, feebly acrid, but not disagreeable taste, for which reason it is sometimes erroneously called balm of Gilead (514).

ACTION AND USES.—It has medical properties similar to the other turpentines and copaiba, but is rarely employed as a remedial agent. It is most valued for **mounting microscopic objects,** for which its beautiful and durable, uncrystalline transparency peculiarly fits it.

OFFICIAL PREPARATION.

Collodium Flexile (5 per cent.).

525. **PIX CANADENSIS.**—CANADA PITCH or HEMLOCK PITCH. An oleoresin obtained from the North American hemlock spruce, **A'bies canaden'sis** Carriere. Resembles Pix Burgundica (526) in appearance, properties, and uses; it is somewhat darker red-brown in color and is much more fusible; odor weak, peculiar; taste very feeble. Rosin is a common adulteration.

526. **PIX BURGUNDICA.**—BURGUNDY PITCH. The resinous exudation pre-

pared from **Abies excelsa** Poiret. Off. U. S. P. 1890. (Fam. Penaceæ, U. S. P. 1900.) A reddish-brown or yellowish-brown, opaque or translucent solid when pure, gradually taking the form of the vessel in which it is contained; brittle, breaking with a shining, conchoidal fracture; at body heat it becomes soft and adhesive; odor agreeable, somewhat aromatic, terebinthinate; taste aromatic and sweetish, not bitter. A mixture of common pitch, rosin, and turpentine melted together and agitated with water, is often substituted for Burgundy pitch, but may be detected by its insolubility in warm glacial acetic acid. Terebinthina cocta, a residue from the distillation of turpentine with water, and Resina pini (white turpentine), fused in hot water and strained, are allied products resembling the former, but these later become crystalline. *Constituents:* Volatile oil (smaller proportion than in turpentine), water, and resin. Gentle rubefacient and stimulant, in chronic rheumatism, etc., in plasters.

Emplastrum Picis Burgundicæ (80 per cent.), U. S. P. 1890.
Emplastrum Picis Cantharidatum (92 per cent., with cerate of cantharides), U. S. P. 1890.

527. **SUCCINUM.**—AMBER. A fossil resin from extinct coniferous trees, found in greater or less quantities in every quarter of the globe; the largest deposits occur in the region surrounding the Baltic Sea, where it has been washed upon the shore. In small, irregular pieces, usually light or deep yellowish-brown, sometimes reddish-brown, generally translucent; tasteless and odorless, but emits an agreeable, aromatic odor when heated. It is almost insoluble in water, alcohol, ether, or oils, slightly soluble in chloroform. Used for fumigation, for the preparation of succinic acid and oil of amber, and in the arts.

527 **a. OLEUM SUCCINI.**—OIL OF AMBER. A light yellowish-brown or amber-colored liquid (colorless when pure), having a balsamic, empyreumatic odor, and a warm, acrid taste. On exposure to light and air it thickens and becomes darker, ultimately solidifying into a black mass. With fuming nitric acid it acquires a red color, changing after a time into a brown, resinous mass having a peculiar musk-like odor. It is often adulterated with oil of turpentine, which may be detected by its throwing down a solid camphor when hydrochloric acid gas is passed through the mixture. Stimulant, antispasmodic, and irritant. Dose: 5 to 15 ♏ (0.3 to 1 Cc.). Externally in liniments.

528. **DAMMARA.**—DAMMAR. GUM DAMMAR. A spontaneous, resinous exudation collected in the East Indies from **A′gathis dam′mara** Richard. Transparent, straw-colored, rounded masses, almost free from odor and taste, and breaking with a glossy, conchoidal fracture. Used mostly for varnishes.

529. **KAURI RESIN.**—KAURI GUM. A resin dug in large quantities from the soil in New Zealand, where it has exuded from **Dam′mara orienta′lis.** It is in large cream-colored or amber-colored masses. Used as a vulnerary in skin diseases; also used as a substitute for collodion, leaving an adherent, impervious, resinous varnish over the wound.

530. **SANDARACCA.**—SANDARAC. A resin exuding spontaneously from the bark of a North African evergreen tree, **Calli′tris quadrival′vis** Ventenat. Small rounded masses about the size of a pea, of a yellowish color; it resembles mastic somewhat, and is often substituted for it on account of its lower price, but a simple means of distinction is afforded in its becoming pulverulent (not adhesive) when chewed. It was formerly used as a mild stimulant in ointments and plasters, but is now mostly used for varnishes. Its powder is used as a pounce to prevent ink from spreading on paper or cloth.

ORCHIDACEÆ.—Orchis Family.

Perennial herbs, sometimes parasitic, with perfect, irregular, and usually showy *flowers*, the *stigma* having a broad, glutinous surface (except in Cypripedium); the (usually single) *anther* is sessile on the style; it is 2-celled, each cell containing one or more waxy masses of pollen, pollinia (Fig. 115).

Synopsis of Drugs from the Orchidaceæ.

A. *Rhizomes.*
CYPRIPEDIUM, 531.
Corallorrhiza, 532.

B. *Tuber.*
Salep, 533.

C. *Fruit.*
VANILLA, 534.

531. CYPRIPEDIUM.—Cypripedium.

LADIES' SLIPPER. *Ger.* GELBFRAUENSCHUB-WURZEL.

The dried rhizome and roots of **Cypripe'dium hirsutum** Miller, of **Cypripedium parviflo'rum** Salisbury, and **Cypripedium pubescens** Willdenow.

Botanical Characteristics.—*Generic characters.*—Rootlets of many tufted fibers. *Stem* about a foot high, from a rhizome. *Leaves* large, many-nerved, sheathing at the base. *Sepals* 3, spreading; *petals* 3, forming a large inflated sac; pollen loose and powdery or somewhat granular; *stigma* terminal, broad, moist, and roughish.

Cypripedium pubescens. *Stem* 2 feet high, pubescent. *Leaves* broadly oval, acute, pubescent. *Sepals* linear-lanceolate; *petals* (lips) pale yellow.

Cypripedium parviflorum. *Stem* 1 to 2 feet high, pubescent. *Leaves* oblong-lanceolate. *Flowers* fragrant, bright yellow, about one-third the size of *C. pubescens.*

Habitat.—North America, in swampy regions.

Description of Drug.—A horizontal, somewhat curved rhizome, about the thickness of a quill and 100 mm. (4 in.) or less in length, of a dark brown or light orange-brown color; on the upper side it is closely covered with **deeply concave stem-scars** about the width of the rhizome, and on the lower side with **smooth, simple, wavy rootlets, abruptly descending,** varying in length from 100 to 500 mm. (4 to 20 in.); cortical parenchyma thick, wood-bundles and nucleus sheath indistinct; fracture of rhizome short, of roots fibrous; odor somewhat valerian-like, diminishing with age; taste sweetish, bitter, somewhat pungent at the last; adulterated with hydrastis canadensis and polygalla senega.

Cypripedium parviflorum has the rhizome bent two or three times, almost at right angles, and is of a brighter orange-brown color; the rootlets are shorter and less wavy.

Constituents.—Volatile oil (a trace), a volatile acid, resins, tannin, sugar, starch, and fixed oil. The active principle has not yet been

isolated, but the virtues of the drug are supposed to reside in the volatile oil and a bitter principle (probably a glucoside).

ACTION AND USES.—Diaphoretic, **nerve stimulant, and antispas-**

FIG. 206.—Cypripedium—Leaf and flower. (Photograph.)

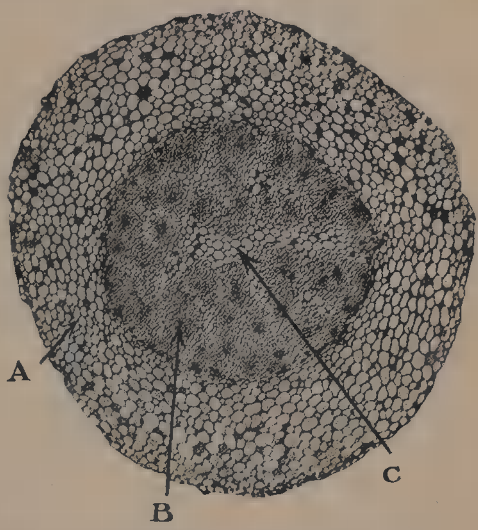


FIG. 207.—Cypripedium—Cross-section of rhizome. (20 diam.) A, Cortex. B, Vascular bundle. C, Ground tissue. (Photomicrograph.)

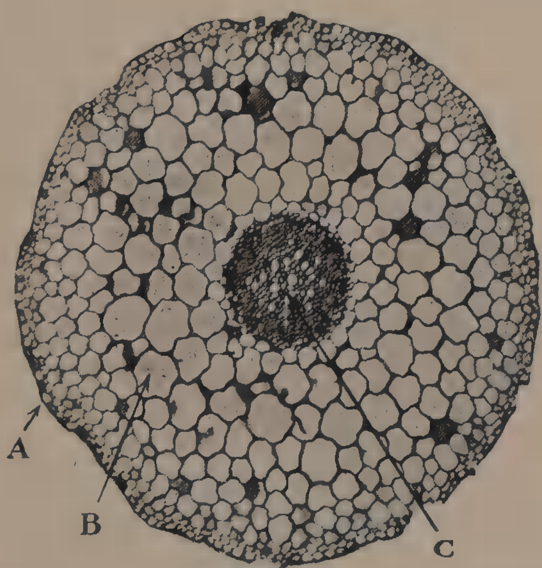


FIG. 208.—Cypripedium—Cross-section of rootlet. (30 diam.) A, Epidermis. B, Parenchyma of cortex. C, Xylem. (Photomicrograph.)

modic, less powerful than valerian. It is valuable as a substitute for opium in the treatment of children. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Cypripedii, ...Dose: 8 to 15 ♏ (0.5 to 1 Cc.).

532. **CORALLORRHIZA ODONTORRHIZA** Nuttall.—CRAWLEY. CORAL ROOT. The rhizome of a parasitic, leafless herb growing throughout the United States east of the Mississippi. "A prompt and powerful diaphoretic, with sedative properties. A combination with blue cohosh is a good emmenagogue." Dose: 15 to 30 gr. (1 to 2 Gm.).

533. **SALEP.**—SALEP. The tubers of **Or'chis mas'cula** and **Orchis morio** Linné. *Habitat:* Europe. Frequently comes in powder. It is a farinaceous, gummy substance, somewhat analogous to tragacanth in composition. Demulcent and nutritive.

534. VANILLA.

VANILLA. *Ger.* VANILLE.

The full-grown but immature fruit of **Vanil'la planifo'lia** Andrews, cured in the customary manner.

BOTANICAL CHARACTERISTICS.—A fleshy, climbing orchid with long, smooth, dark green stem sending out at the nodes aërial rootlets which fasten it to the tree or other support. *Leaves* sessile, fleshy, tough, veinless. *Flowers* pale yellowish, in loose axillary racemes. *Fruit* a pod.

SOURCE AND VARIETIES.—Of the genus Vanilla there are some twenty-three species recognized, a few only of which are used and cured as the commercial vanilla, a product of cultivation mainly. The fruit is chiefly cultivated in Mexico and Bourbon, and to a greater or less extent in the West Indies, Java, Mauritius, Ceylon, the Fijis, and Straits Settlements.

COLLECTION AND CURING.—The fruits are collected before they are ripe, just as they begin to turn yellow, then placed between woolen blankets in a sweating-box and left there for thirty-six hours, being afterward exposed to the noonday sun just long enough to dry off the perspiration which was thus produced. This process is repeated until the fruit has a uniform blackish chocolate color, until the curer determines the process finished and the fruit ready for packing.

ARTIFICIAL POLLENIZATION OR FECUNDATION.—In Mexico and Guinea fertilization is left to natural influences, as by insects and by the wind; but in Reunion (Bourbon) artificial fecundation is resorted to because there is a total lack of the necessary insect life. Pollenization consists in holding the flower with the thumb and finger of the left hand, and, with a splinter of wood or bamboo held in the right hand, raising up the labellum between the pollen and the stigma, then with the forefinger of the left hand pressing the former down upon the latter. Transversely are seen several rib-like processes extending inward. These are the placentæ which support the numerous minute seeds. Projecting into the central cavity and borne on the inner cell-wall

are unicellular papillose hairs; these secrete oil and resin, which elaborate vanillin.

DESCRIPTION OF DRUG.—Linear, somewhat triangularly compressed pods from 150 to 250 mm. (6 to 10 in.) long, 8 mm. (1/3 in.) thick, attenuated at the base, where they are curved more or less into a hook; flexible;

FIG. 209.—*Vanilla planifolia*—Branch showing leaf and flowers.

externally finely furrowed longitudinally, dark brown, shining, unctuous, often covered with an incrustation of fine, acicular crystals of vanillin;* they split lengthwise into two unequal valves, showing numerous minute, lenticular, glossy black seeds imbedded in a black, oily pulp, which also contains shining, acicular crystals. The pecu-

* An adulteration of benzoic acid crystals can be detected by the latter having rhomboidal form. Most excellent papers on Vanilla are found: "Amer. Druggist," 1898, pp. 36, 37, and "Western Druggist," December, 1897.

liar, strong, aromatic odor resides chiefly in the pulp; taste warm, aromatic, sweetish.

CONSTITUENTS.—The aroma of vanilla chiefly depends upon a crystalline principle, **vanillin** ($C_6H_3.OH.OCH_3.CHO$, m-methoxy-p-oxybenzaldehyde), which does not exist in the green pods, but is developed during the process of curing, and forms the frosty inflorescence upon their surface. It is found in many other plants, being first made artificially from coniferin, a glucoside found in the cambium of the pine; it is now largely made from oil of cloves by reactions upon the eugenol.

FIG. 210.—Bourbon Vanilla.

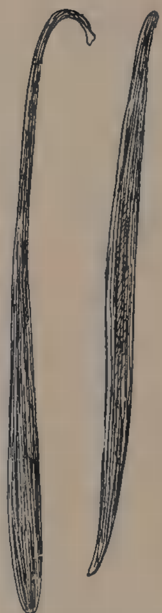


FIG. 211.—Mexican Vanilla.

FIG. 212.—Tahiti Vanilla.

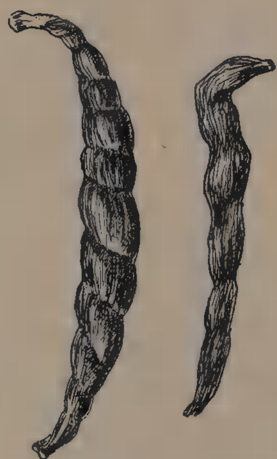


FIG. 213.—Wild Vanilla.

Preparation of Vanillin.—Treat alcoholic extract with ether, evaporate, and treat residue with boiling water, when needles of vanillin are deposited. Prepared artificially on large scale from coniferin, $C_{10}H_{22}O_8 + 2H_2O$, a compound occurring in the sap of the cambium in the Coniferæ. This is first fermented and finally oxidized.

ACTION AND USES.—Carminative, stimulant, aphrodisiac, anti-hysteric. Dose: 5 to 30 gr. (0.3 to 2 Gm.). It is rarely employed medicinally, being principally used as a **flavor.**

OFFICIAL PREPARATION.

Tinctura Vanillæ (10 per cent.), ...Flavoring.

SCITAMINEÆ.—Banana Family.

A tropical order, many species of which have a pungent principle in their rhizome or root; other species yield an abundance of starch and coloring matter.

Synopsis of Drugs from the Scitamineæ.

A. *Rhizomes.*
ZINGIBER, 535.
Galanga, 536.
Zedoaria, 537.
Curcuma, 538.

B. *Fruit.*
CARDAMOMUM, 539.

C. *Seeds.*
Granum Paradisi, 540.

535. ZINGIBER.—GINGER.

GINGER. *Ger.* INGWER.

The dried rhizome of **Zin′giber officina′le** Roscoe (Fam. Zingiberaceæ, U. S. P. 1900), deprived of periderm.

BOTANICAL CHARACTERISTICS.—*Root-stock* biennial, creeping; *stem* 3 to 4 feet high; *leaves* linear-lanceolate, smooth. *Spikes* radical, each flower bracteate; *lip* 3-lobed; *stamens* 3, 2 abortive; *capsule* 3-celled, 3-valved.

HABITAT.—Africa, Hindustan; cultivated in the West Indies and tropics.

DESCRIPTION OF DRUG.—A flattened rhizome, from 25 to 100 mm. (1 to 4 in.) long, with large **club-shaped lobes on one side**; deprived of the corky layer by scraping, and bleached, leaving a **pale buff-colored,** striate surface, sometimes covered with a white powder of calcium carbonate from being steeped in milk of lime; fracture mealy and rather fibrous, showing a whitish interior dotted with numerous small, orange-colored oil and resin-cells. Transverse sections show a parenchymatous meditullium containing scattered resin-cells and numerous fibrovascular bundles, which latter are less abundant outside of the nuclear sheath. The central cylinder is quite broad as compared with the cortical layer; **aromatic and spicy; pungent.**

VARIETIES.—The above-described root, Jamaica ginger or white ginger, is the finest variety, yielding 5 per cent. oleoresin. African ginger is shorter, with broadly linear or oblong lobes, and is not deprived of its light brown, corky layer. Chinese ginger is also a coated rhizome, but has short stumpy lobes. East India ginger is scraped on the flat side, leaving the cork remaining on the edges. It yields 8 per cent. of oleoresin. Green ginger consists of the rhizome sent to market without drying; black ginger, of the rhizome steeped in boiling water before drying, after which it has a black, horny structure. The preserved ginger is an article on the market which consists of soft, yellowish-brown pieces, obtained by steeping the fresh ginger in hot syrup and carefully bottling.

Powder.—Brownish-yellow to brown. Characteristic elements: Parenchyma of cortex with starch, oval to elliptical (8 to 15 μ by 18 to 75 μ), cells, large, loosely united; sclerenchyma with bast fibers long, thin-walled (15 to 25 μ in

diam.), porous; ducts, large; oil and resin cells with suberized walls. African ginger has cork present.

CONSTITUENTS.—**Volatile oil,** 1 to 2 per cent. (consisting of camphene and phellandrene), and gingerol, the former probably giving to it its aromatic properties, and a resinous, viscid, inodorous extractive its

FIG. 214.—*Zingiber officinale.*

hot, pungent taste; also resin, starch (20 per cent.), and mucilage. Jamaica ginger yields about 5 per cent. of oleoresin, the East India ginger about 8 per cent.

ACTION AND USES.—**Stimulant,** carminative, and stomachic, often used as an adjuvant to bitter, tonic preparations. Dose: 8 to 30 gr. (0.5 to 2 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Zingiberis (20 per cent.), ... Dose:	15 to 60 ♍ (1 to 4 Cc.).
Fluidextractum Zingiberis, ...	8 to 30 ♍ (0.5 to 2 Cc.).
Syrupus Zingiberis (3 per cent.), ...	2 to 6 fl. dr. (8 to 24 Cc.).
Pulvis Aromaticus (35 per cent.), ...	10 to 30 gr. (0.6 to 2 Gm.).
Pulvis Rhei Compositus (10 per cent. of ginger), ...	1 to 3 dr. (4 to 12 Gm.).
Oleoresina Zingiberis, ...	½ to 2 ♍ (0.0324 to 0.13 Cc.).

FIG. 215.—Cross-section of ginger, outer portion of peeled rhizome. *a*. Fragment of cork. *b*. Fibro-vascular bundles. *c*. Resin cell. *d*. Parenchyma. (15 diam.)

FIG. 216.—Zingiber—Jamaica, showing lobes of rhizome, peeled and unlimed. (½ natural size.) (Photograph.)

536. **GALANGA.**—GALANGAL. The rhizome of **Alpi'nia officina'rum** Hance. *Habitat:* China. **Reddish-brown,** cylindrical, branched, about 100 mm. (4 in.) long, and about the thickness of the thumb, marked with circular or diagonally **annular, whitish rings,** the remains of former leaf-sheaths;

FIG. 217.—Zingiber—Chinese limed and peeled. ($\frac{2}{3}$ natural size.) (Photograph.)

FIG. 218.—Zingiber—African, half peeled. ($\frac{2}{3}$ natural size.) (Photograph.)

FIG. 219.—*Curcuma longa*.

internally orange-brown, dotted with numerous brownish-yellow resin-cells; **odor and taste ginger-like.** Small galangal, or galanga minor, does not exceed the little finger in size, is darker in color, and has a stronger taste and odor. Like ginger, their activity is due to a volatile oil and a resin, and they have the same medicinal action. (Highly magnified **starch** grains, see Fig. 370.)

537. **ZEDOARIA.**—ZEDOARY. The rhizome of **Cur'cuma zedoar'ia** Roxburgh. There are two kinds, the long and the round, both coming from the East Indies. Externally grayish-white, internally brown, hard, compact; odor aromatic; taste spicy, camphoraceous. The drug comes into market in slices and disks. It is used as an aromatic stimulant, and possesses properties similar to but inferior to those of ginger. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

538. **CURCUMA.**—TURMERIC. The rhizome of **Cur'cuma lon'ga** Linné. *Habitat:* Southern Asia and East Indies, the best coming from China. Cylindrical pieces (*Curcuma longa*), about as thick, but not so long, as the finger, tuberculated and somewhat contorted; externally yellowish-gray,

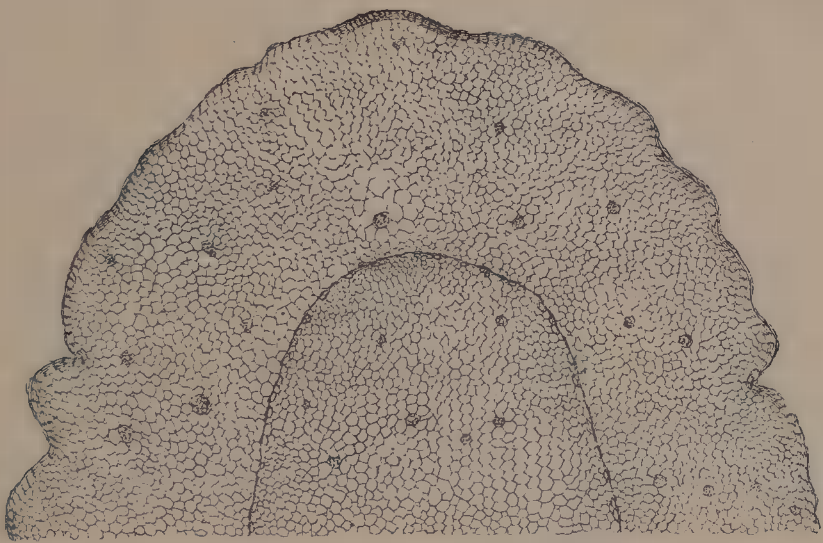


FIG. 220.—*Curcuma longa*—Cross-section of the rhizome.

internally deep orange-yellow, with a darkish ring marking the circular nucleus sheath; hard, compact, breaking with a glossy, waxy fracture; odor feeble but peculiar; taste aromatic, pungent, bitter.

Curcuma rotunda is round or oval, about the size of a pigeon's egg, or larger, marked externally with annular rings. Both forms of root are derived from the same plant, one being a modification of the other.

CONSTITUENTS.—Volatile oil, a viscid oil, a pungent resin, pasty starch, and a peculiar yellow coloring matter called curcumin, **turned brownish by alkalies,** becoming violet on drying; with boracic acid it produces an orange tint, changed to blue by alkaline solutions. Stimulant and tonic, but rarely used in that way, except in India, where it is used as a condiment, like ginger. It is used in pharmacy for **coloring ointments and tinctures,** and for preparing turmeric test-paper.

Preparation of Curcumin.—Obtained pure after removing the oil by exhausting the residual powder with ether, evaporating and recrystallizing from alcohol. Crystals yellow, with a vanilla-like odor.

539. CARDAMOMUM.—Cardamom.

CARDAMOM. *Ger.* CARDAMOMEM.

The dried ripe fruit of **Eletta'ria re'pens** Baillon. (Fam. Zingiberaceæ, U. S. P. 1900.)

Botanical Characteristics.—Rhizome fleshy-fibrous. *Stem* 6 to 9 feet high. *Leaves* lanceolate, pubescent above, silky beneath. *Flowers* borne on scapes; *anthers* 2-lobed. *Capsules* 3-celled, 3-valved.

Habitat.—Malabar; cultivated in India.

Description of Drug.—**Triangular-ovate,** from 12 to 37 mm. ($\frac{1}{2}$ to $1\frac{1}{2}$ in.) long, with flat, ribbed sides, in the center of which are longitudinal furrows marking the positions of the cell-partitions; valves three, opening longitudinally at the rounded angles; central placenta. **The pericarp** is of a yellowish or buff color, leathery, and nearly tasteless. **Internally** 3-celled, each containing from 5 to 7 reddish-brown, irregularly angular, rugose seeds, having an aromatic odor and taste; these seeds form 75 per cent. of the fruit in the best varieties. The inert pericarp is rejected in making preparations.

Varieties.—Malabar, the choicest, plump, light, and buff color; Aleppo, mostly short and greenish. These two kinds are mostly imported into the United States. Besides these, there are Madras cardamom, oblong, alternated above, pale in color; Ceylon, from *Elettaria major*, $1\frac{3}{5}$ in. (40 mm.) long, triangular, prolonged into a beak, dark gray and brown. This latter variety is of inferior flavor. Round cardamom, from *Amomum cardamomum* of Siam and Java, and *A. globosum* and *A. aromaticum* (Bengal cardamom) are known; also winged Java cardamom, from *A. maximum.* This latter variety has from 9 to 12 wings from the base to the apex, but the Bengal has 9 wings near the apex.

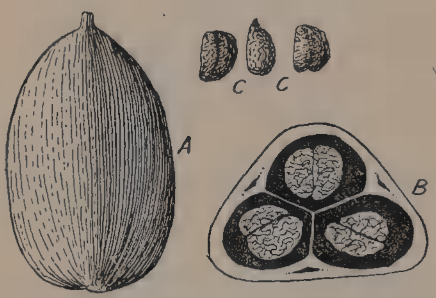


Fig. 221.—Cardamomum. *A.* Whole fruit enlarged. *B.* Cross-section. *C.* Seed.

Powder.—Pale brownish-gray (of seed). Characteristic elements: Parenchyma of pericarp, thin-walled with prismatic calcium oxalate crystals; the pericarp valueless as an aromatic; parenchyma of endosperm with oil, proteid granules and starch, spherical or angular, simple or compound (1 to 4 μ in diam.); seed coat with dark brown stone cells (15 to 20 μ in diam.), inner wall thickened; pericarp has bast fibers very slightly lignified; outer epidermal cells elongated (20 to 30 μ in diam.), tangential walls thickened; oil cells with suberized walls; Ceylon differs from Malabar in containing trichomes and in the measurements of the elements.

Constituents.—The pericarp is almost inert, consisting chiefly of lignin. The seeds abound in a fixed oil (10 per cent.) and a **volatile**

oil (4.6 per cent.), consisting of terpene, diterpene, and terpineol, with rhombohedric masses of albuminous matter, gum, and about 15 per cent. of ash, containing 8 to 10 per cent. of manganese.

ACTION AND USES.—Aromatic, stimulant, stomachic, and carminative, used principally in this country as an **adjuvant.** Dose: 5 to 15 gr. (0.3 to 1 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Cardamomi (20 per cent.), ... Dose:	1 to 2 fl. dr. (4 to 8 Cc.).
Tinctura Cardamomi Composita (2.5 per cent., with cassia cinnamon, caraway, and cochineal), ...	1 to 3 fl. dr. (4 to 12 Cc.).
Pulvis Aromaticus (15 per cent.), ...	10 to 30 gr. (0.6 to 2 Gm.).

540. **GRANUM PARADISI.**—GRAINS OF PARADISE. GUINEA GRAINS. The seeds of **Amo'mum gra'na paradi'si** and **Amo'mum melegue'ta.** Small, roundish, somewhat cuneiform; externally finely warty, reddish-brown; internally white. When rubbed, they emit a feebly aromatic odor; taste hot and peppery. Action somewhat resembles pepper.

BROMELIACEÆ.—Pineapple Family.

541. **ANANASSA.**—PINEAPPLE. The fruit of **Ananas'sa sati'va** Schultz. The fresh juice contains the digestive ferment, bromelin, which is a powerful and rapid digestant of albumen, both animal and vegetable, acting in the presence of either acid or alkaline carbonates, but most energetically in neutral solutions. It is more nearly related to trypsin than to pepsin.

HÆMODORACEÆ.—Bloodwort Family.

542. **ALETRIS.**—COLIC ROOT. STARWORT. The rhizome of **Alet'ris farino'sa** Linné. *Habitat:* United States. Small, crooked, about the size of a quill, flattened and tufted above and beset with wiry, white rootlets below. Alcohol extracts its bitter principle. Bitter tonic, diuretic, and vermifuge; used extensively in the treatment of uterine diseases. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

IRIDEÆ.—Iris Family.

Perennial herbs, with equitant, 2-ranked leaves, the flowering stem arising from a rhizome or corm.

543. **IRIS.**—IRIS VERSICOLOR. BLUE FLAG. (1890.) A horizontal, jointed rhizome, generally cut into longitudinal slices; externally brown, closely annulate from the leaf-sheath remnants, and near the broad flattened end crowded with long, simple rootlets. *Constituents:* Acrid resin 25 per cent., fixed oil, starch, gum, tannin, sugar, iridin, and indications of a brownish, viscid, amorphous alkaloid. *Preparation of Iridin:* Obtained by precipitating hot alkaline solution by an acid. The eclectic method of preparation is to precipitate concentrated alcoholic tincture with water; mix dried precipitate with equal quantity of licorice root. Cholagogue, cathartic and alterative. Dose: 10 to 30 gr. (0.6 to 2 Gm.).

Fluidextractum Iridis (U. S. P. 1890), .. Dose:	10 to 30 ♏ (0.6 to 2 Cc.).
Extractum Iridis (U. S. P. 1890), ...	1 to 3 gr. (0.065 to 0.2 Gm.).

544. **IRIS FLORENTINA.**—ORRIS ROOT. The rhizome of **I'ris florenti'na, Iris pallida,** and **Iris germanica** Linné. *Habitat:* Northern Italy. In

club-shaped pieces or joints, from 75 to 125 mm. (3 to 5 in.) in length, a broad depression or scar terminating the broad end. Externally white, peeled; fracture short, mealy, faintly yellowish-white; **odor** violet-like; taste mealy, bitterish, and somewhat acrid. It contains iridin, irone, $C_{13}H_{20}O$, a ketone of violet odor, acrid resin, starch, mucilage, bitter extractive, and orris camphor, consisting of a fat impregnated with volatile oil. Cathartic, diuretic. Dose: 5 to 15 gr. (0.3 to 1 Gm.). Chiefly used in tooth-powders and perfumes. (Highly magnified starch grains of Iris, see Fig. 371.)

FIG. 222.—*Crocus sativus*—Plant, flower, and stigma.

545. **CROCUS.**—SAFFRON. The stigmas of **Cro'cus sati'vus** Linné. Asia Minor and Greece; cultivated for market in Spain, France, and other temperate countries of Europe; also cultivated in the southeastern counties of Pennsylvania. Commercial saffron is mostly of French or Spanish origin; a product of the Cape of Good Hope known as Cape saffron, resembling the genuine in odor, is a flower of a small plant belonging to the Scrophulariaceæ ("Pharm. Journal," VI, 462, 1865). "American saffron" consists usually of safflower. The commercial or "hay saffron" consists of **orange-brown stigmas**, separate, or united (three) to the top of the style,

about 30 mm. ($1\frac{1}{5}$ in.) long, almost filiform, enlarging toward the top, which is toothed; their edges are rolled in, giving them a flattish-tubular appearance; crisp and somewhat elastic; orange-brown; odor peculiar, aromatic; taste pungent, bitterish. In selecting saffron the above characteristics should be borne in mind; the drug should not emit an offensive smell when thrown upon live coals. If it has a musty flavor or a black, yellowish, or whitish color, it should be rejected. If the cake saffron be purchased, those should be selected which are close, tough, and firm in tearing. Owing to its high price, saffron offers a great field for adulteration, which is done in various ways. The commonest is to mix the stigmas with the styles, which may be distinguished by their lighter color. Old saffron and that deprived of its coloring matter leaves an oily stain when pressed between paper, due to the fixed oil with which they are covered to conceal their false nature. The florets of other flowers, as calendula, carthamus, and arnica, may be detected by dropping them into water, when their characteristic forms will come out. Mineral adulterants, which are sometimes found to the extent of 20 per cent., will subside to the bottom when the suspected drug is placed on water; carbonate of lime will effervesce when a drop of acid is placed on the suspected drug. *Constituents:* An orange-red coloring matter, which gives to saffron its chief value; a glucoside, usually called crocin, $C_{44}H_{70}O_{28}$, but formerly called polychroit, because of the many different colors it gives with acids; crocetin, $C_{34}H_{46}O_9$, and a volatile oil, $C_{10}H_{16}$, upon which its medicinal virtues depend. Saffron has fallen into almost complete disuse among practitioners of the United States and Great Britain, but it is occasionally used in domestic practice in the form of a tea, to promote eruption in measles, scarlet fever, and other exanthematous diseases. Dose: 5 to 30 gr. (0.3 to 2 Gm.). Chiefly used for **coloring preparations.**

Tinctura Croci (10 per cent.). (U. S. P. 1890), ...Dose: 1 to 2 dr. (4 to 8 Cc.).

DIOSCŒRACEÆ.—Yam Family.

546. **DIOSCOREA.**—Wild Yam. Colic Root. The rhizome of **Diosco'rea villo'sa** Linné. *Habitat:* United States. Expectorant, diaphoretic, antispasmodic, and a stimulant to the intestinal canal. It is a valuable remedy in bilious colic. Dose: 15 to 60 gr. (1 to 4 Gm.), in fluidextract.

LILIACEÆ.—Lily Family.

Herbs (rarely woody) with flowering stems springing from bulbs or corms with the *leaves* parallel-nerved, except in the tribe Smilaceæ, where they are netted-veined. The *perianth* consists of six divisions; *anthers* introrse; *ovary* superior, usually 3-celled.

Synopsis of Drugs from the Liliaceæ.

A. *Root.*
- **SARSAPARILLA,** 547.

B. *Rhizomes.*
- **CONVALLARIA,** 548.
- **VERATRUM,** 549.
- Veratrum Album, 549 a.
- Polygonatum, 551.
- Chamælirium, 552.
- Trillium, 553.
- Asparagus, 554.

C. *Bulbs.*
- Allium, 555.
- **SCILLA,** 556.

D. *Corm.*
- **COLCHICI CORMUS,** 557.

E. *Seeds.*
- **COLCHICI SEMEN,** 558.
- Sabadilla, 550.

F. *Inspissated Juices.*
- **ALOE,** 559.
- Aloe Barbadensis, 559 a.
- Aloe Capensis, 559 b.
- Aloe Socotrina, 559 c.

G. *Resin.*
- Xanthorrhœa, 560.

H. *Leaves.*
- Erythronium, 561.

547. SARSAPARILLA.—Sarsaparilla.

SARSAPARILLA. *Ger.* SASSAPARILLE.

The dried root of **Smi'lax officinalis** Kunth, **Smi'lax med'ica** Chamisso et Schlechtendal, **Smilax papyra'cea** Duhamel, **Smilax ornata** Hooker, and of other undetermined species of Smilax.

Botanical Characteristics.—Evergreen, climbing, shrubby plants. *Stem* prickly. *Leaves* alternate, netted-veined, coriaceous, ovate-oblong, with a cordate base, 1 foot long and 4 to 5 inches broad. *Flowers* in axillary clusters, diœcious; *stigmas* 3, sessile. *Fruit* a globular, 1- to 3-seeded berry.

Habitat.—Tropical America, in swampy forests.

Description of Drug.—The varieties used in medicine have a thick, knotty rhizome (which, if present, should be removed) from which grow in a horizontal direction the fleshy roots. These appear in the market several feet in length, cylindrical, about the thickness of a quill, very flexible; externally longitudinally wrinkled, of various colors, depending upon the variety, generally ash-colored, grayish-brown, or reddish-brown; internally whitish, horny, or occasionally mealy; nearly inodorous; taste mucilaginous, bitter, and acrid.

Structure.—A transverse section shows a thin, easily removed epidermis overlaying a thick cortical layer; this inner bark consists of loose parenchyma, the cells of which, when not devoid of solid contents, are filled with starch-granules or paste, and occasionally calcium oxalate raphides; a brownish ring (nucleus sheath) separates it from the woody center, which is made up of elongated woody cells. A small pith runs through the center of this woody zone.

Varieties.—There are four principal varieties of sarsaparilla, differing somewhat in appearance, and especially in the condition of the starch.

(*a*) Mealy—starch in granules.

The Honduras sarsaparilla is the kind most generally used in this country. It is grayish or grayish-brown from adhering dirt, beset with a few fibers, and comes in compact cylindrical bundles 2 or 3 feet long.

Brazilian sarsaparilla (Rio Negro, Para, or Lisbon sarsaparilla). Considered to be the finest variety. Dark brown or blackish-brown, with a thick cortical layer and pith, and a narrow, woody zone.

(*b*) Pasty—starch in a paste.

Jamaica or red sarsaparilla is of a reddish color externally; it is said to be the richest in extractive and to contain the best quality of starch. The name bearded sarsaparilla has been applied to it, from the numerous fibers attached.

Mexican sarsaparilla is deeply wrinkled, and brownish-gray from

adhering earth. The woody zone and pith are about equal in thickness, each being about half as broad as the cortical layer.

Powder.—Grayish-brown. Characteristic elements: Parenchyma cells of cortex elongated (40 to 60 μ across), or cylindrical with spherical starch grains (2 to

Fig. 223.—*Smilax officinalis*—Portion of vine and rhizome.

4 μ in diam.), simple and 2 to 4 compound; raphides (6 to 8 μ by 60 to 175 μ); sclerenchyma with bast fibers, long, thick-walled, porous; ducts, large, reticulate, spiral, annular; epidermis with polygonal brown cells, some developed into one-celled, thin-walled trichomes. Powders of commercial varieties differ, but are not easily compared. (For highly magnified starch grains, see Fig. 375.)

Constituents.—The activity of sarsaparilla depends upon an acrid

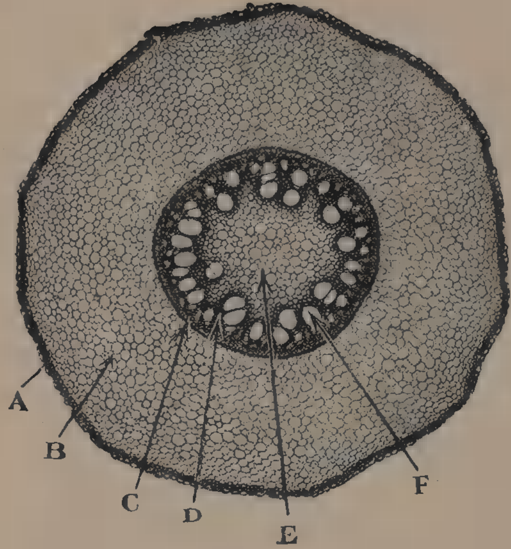


FIG. 224.—Sarsaparilla, Honduras—Cross-section of root. (18 diam.) A, Epidermis. B, Parenchyma of cortex. C, Endodermis. D, Wood parenchyma and fibers. E. Medulla. F, Water tube. (Photomicrograph.)

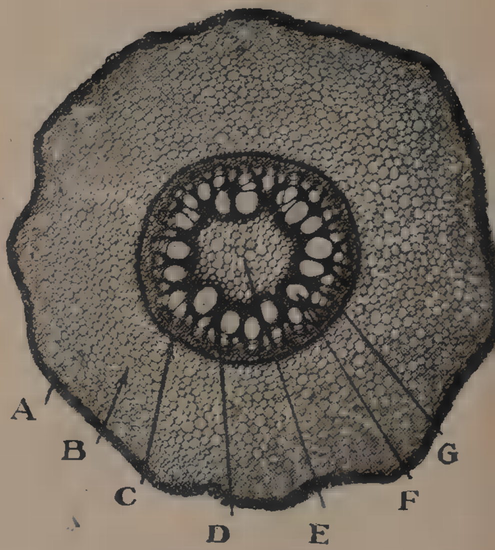


FIG. 225.—Sarsaparilla, Jamaica—Cross-section of root. (21 diam.) A, Epidermis. B, Parenchyma of cortex. C, Endodermis. D, Wood parenchyma and fibers. E, Medulla. F, Water tube. G, Phloëm. (Photomicrograph.)

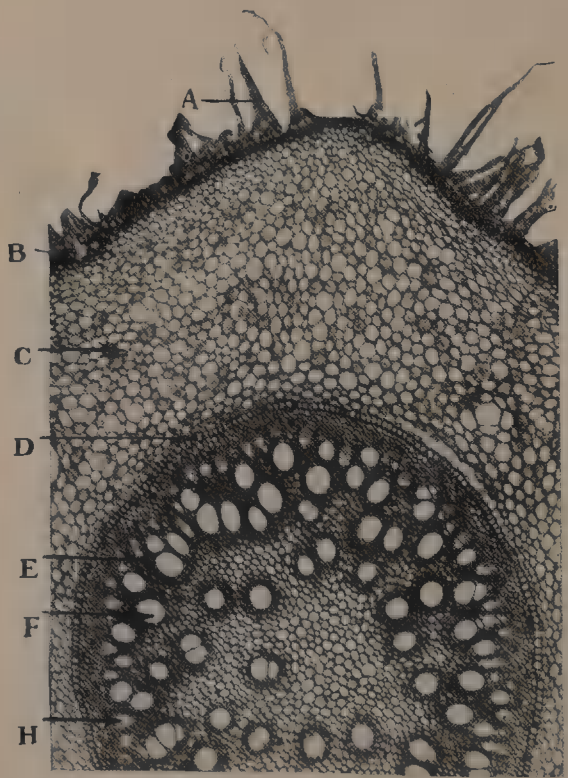


FIG. 226.—Sarsaparilla, Mexican—Cross-section of root. (32 diam.) A, Root hairs. B, Cork. C, Parenchyma of cortex. D, Endodermis. E, Wood parenchyma and fibers. F, Water tube. H, Phloëm. (Photomicrograph.)

glucoside, **parillin,** $C_{26}H_{44}O_{10} + 2\frac{1}{2}H_2O$ (variously termed smilacin, parillinic acid, pariglin, etc.), frothing with water and otherwise closely resembling saponin in action. Kobert states that two other glucosides are present, saponin (sarsaparilla saponin), $5(C_{20}H_{32}O_{10})$-$2\frac{1}{2}H_2O$, and sarsa-saponin, $12(C_{22}H_{36}O_{10}) + H_2O$. These two latter differ from parillin in their being soluble, while parillin is insoluble. The latter constituent is the most poisonous.

Preparation of Parillin.—Exhaust with warm alcohol and concentrate the liquid to a syrup; add $1\frac{1}{2}$ times its weight of water; macerate for several days, when a yellow precipitate will form; decant and mix with alcohol, and wash on a filter with 20 per cent. alcohol.

ACTION AND USES.—The efficiency of sarsaparilla as a remedial agent has been and is still much questioned, some declaring it almost inert, others ascribing to it valuable alterative and antisyphilitic properties. Preparations from good, well-preserved specimens are perhaps beneficial remedies in scrofulous affections, and as general blood-purifiers. Dose: 30 to 60 gr. (2 to 4 Gm.).

OFFICIAL PREPARATIONS.

Fluidextractum Sarsaparillæ, ...	Dose: 30 to 60 ♏ (2 to 4 Cc.).
Syrupus Sarsaparillæ Compositus (fl'ext. 20 per cent., with the fluidextracts of glycyrrhiza and senna, and the oils of sassafras, anise, and gaultheria),	2 to 4 fl. dr. (8 to 15 Cc.).
Fluidextractum Sarsaparillæ Compositum (75 per cent., with glycyrrhiza, sassafras, and mezereum), ...	$\frac{1}{2}$ to $1\frac{1}{2}$ fl. dr. (2 to 6 Cc.).

548. CONVALLARIA.—CONVALLARIA.

LILY OF THE VALLEY. *Ger.* MAIBLUMEN.

The dried rhizome and roots of **Convalla'ria majal'is** Linné.

BOTANICAL CHARACTERISTICS.—A low, perennial, glabrous herb with slender, running root-stocks. *Leaves* 2, oblong, bright green, and shining. Scape bearing a one-sided raceme of white, bell-shaped *flowers*. *Fruit* a few-seeded red berry.

HABITAT.—North America, Europe, and Northern Asia.

DESCRIPTION OF DRUG.—In pieces from 50 to 75 mm. (2 to 3 in.) long, and about 3 mm. ($\frac{1}{8}$ in.) thick, the upper end gnarled and wrinkled, and with the remnants of the scape and petioles attached; tapering at the small end; annulate nodes beset with a circle of eight or ten long, branching, gray rootlets; externally white; fracture white, tough, and fibrous. Odor distinct; taste sweetish, somewhat bitter and acrid.

CONSTITUENTS.—Two glucosides, **convallarin,** $C_{34}H_{62}O_{11}$ (the emeto-cathartic principle), acrid prisms, scarcely soluble in, but foaming

when shaken with, water; and **convallamarin,** $C_{23}H_{44}O_{12}$, the cardiac-acting principle, a sweetish, afterward bitter, crystalline powder.

Preparation of Convallamarin.—The estimation of the value of the drug is based upon the separation of this constituent. The drug is extracted with alcohol, the tincture treated with subacetate of lead, and filtered; excess of lead removed by careful addition of H_2SO_4; filter, distil off alcohol, add water, neutralize carefully with Na_2CO_3, add solution of tannin. The precipitate of tannin compound is dissolved in 60 per cent. of alcohol, decolorized with animal charcoal, decomposed with zinc oxide. The filtrate is then evaporated to dryness.

ACTION AND USES.—Convallaria was introduced as a safer **cardiac tonic** than digitalis. Its absence of cumulative action was pointed out by therapeutists. "It does not disturb the stomach or cerebro-spinal functions if preparations free from convallarin are used." It is one of the most active **diuretics,** especially in cardiac dropsies. Dose: 5 to 30 gr. (0.3 to 2 Gm.); of convallamarin ½ to 2 gr. (0.0324 to 0.13 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Convallariæ, ...Dose: 5 to 30 ♍ (0.3 to 2 Cc.).

549. VERATRUM.—VERATRUM.

AMERICAN HELLEBORE. *Ger.* GRÜNER GERMER.

The dried rhizome and roots of **Vera'trum vir'ide** Aiton (American), or of **Veratrum album** (White Hellebore) Linné.

BOTANICAL CHARACTERISTICS.—*Roots* fibrous; *stem* 2 to 7 feet high, stout and very leafy, somewhat pubescent. *Leaves* broadly oval, clasping. *Flowers* in dense panicles, yellowish-green. *Capsule* many-seeded.

HABITAT.—North America and Europe.

DESCRIPTION OF DRUG.—Usually in small pieces or large slices. When entire, obconical, from 50 to 75 mm. (2 to 3 in.) long, truncate at the base, tufted above with the inert stem-remnants and leaf-stalks, and beset on all sides with light yellowish-brown rootlets about the thickness of a knitting needle; externally blackish. A **transverse section** shows a dingy white surface dotted with darker colored dots and wavy lines within the nucleus sheath. The larger part of the tissue consists of parenchyma containing starch and calcium oxalate; nucleus sheath wavy, wood-bundles numerous. Rootlets have a thick, cortical parenchyma. Inodorous; taste bitter, very acrid, causing a tingling, benumbing sensation in the tongue. The powder is sternutatory.

Powder.—Brownish-gray. Characteristic elements: Parenchyma of cortex, with starch, ellipsoidal, simple and compound, calcium oxalate in raphides; ducts, spiral, reticulate, scalariform, pitted; epidermal cells, brownish-yellow,

thick-walled; endodermal cells, distinctly pitted. (See starch grains, highly magnified, Fig. 368.)

CONSTITUENTS.—Veratrum viride contains the alkaloids **jervine,** $C_{26}H_{37}NO_3$ (to which the depressant action on the circulation is partly due), **pseudojervine, rubijervine,** and **cevadine,** $C_{32}H_{49}NO_9$ (sternutatory). Veratrum album has almost the same constituents, but contains **veratralbine** instead of cevadine. The **veratroidine**

FIG. 227.—*Veratrum viride*—Branch and rhizome.

of the earlier investigations is probably a mixture of rubijervine and a toxic resin; it causes the emetocathartic action of the drug, and is also sternutatory. Veratrine was at first supposed to be the active principle of the two species of veratrum, but it has been found either to not exist in them, or at most only in very small quantities, the source of this alkaloid being the sabadilla fruit.

ACTION AND USES.—The action of veratrum viride closely resembles that of aconite, being a powerful cardiac depressant and spinal par-

alyzant, but in addition it has a strong emetocathartic action, and consequently overdoses are less likely to prove fatal; death occurs by paralysis of the heart. Dose: 1 to 5 gr. (0.065 to 0.3 Gm.).

OFFICIAL PREPARATIONS.

Tinctura Veratri (10 per cent.), ...	Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.).
Fluidextractum Veratri, ...	1 to 5 ♏ (0.065 to 0.3 Cc.).

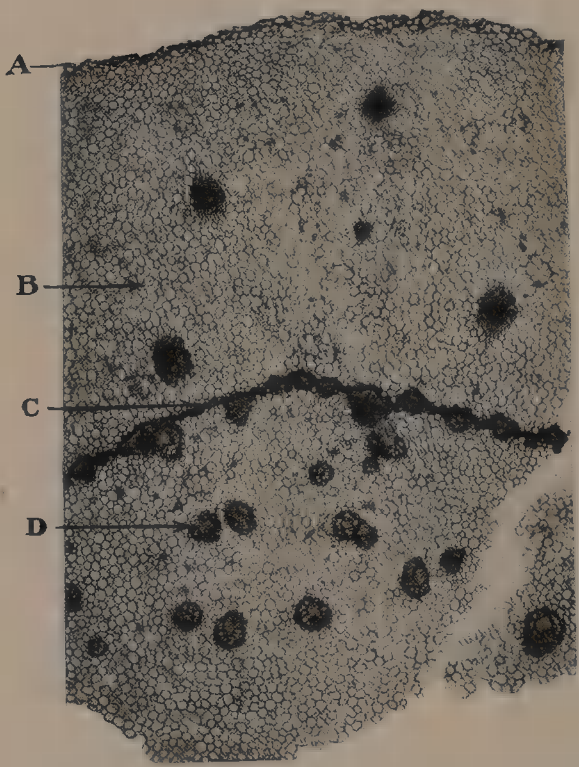


FIG. 228.—*Veratrum viride*—Cross-section of rhizome. (25 diam.) A, Cork. B, Parenchyma of ground tissue. C, Endodermis. D, Vascular bundle. (Photomicrograph.)

550. **SABADILLA.**—CEVADILLA. The seeds of **Vera'trum sabadil'la** Schlechtendal, and of **Asagræa officinalis** Lindley. *Habitat:* Mexico. They occur in commerce mixed with the fruit, which consists of three thin, papery, acuminate follicles, nearly erect, united at the base, opening by a ventral suture, and appearing like a single three-celled capsule. Each follicle contains one or two narrow, oblong or lance-linear seeds, about 6 mm. (¼ in.) long, dark brown or blackish, longitudinally shriveled, slightly winged, flat on one side, convex on the other, somewhat curved; apex pointed; the thin testa incloses a discolored, oily albumen, in the broader end of which is the small, linear embryo; inodorous; taste bitter, oily, strongly and persistently acrid.

CONSTITUENTS.—Sabadilla is the principal source of **veratrine**, $C_{37}H_{53}NO_{11}$ (Veratrina, U. S.), a white powder, intensely acrid and sternutatory. The commercial veratrine is impure; it is a mixture of the alkaloid veratrine with other alkaloids extracted along with it, cevadine, $C_{32}H_{49}NO_9$, cevadilline, $C_{34}H_{53}NO_8$, sebadine, $C_{29}H_{51}NO_8$, and sabadinine.

Preparation of Veratrine.—Remove resin and oil from alcoholic tincture by adding water *q. s.* Decompose native salt (veratrate of veratrine) in filtrate

by means of KOH. Take up alkaloid with alcohol. Purify by converting into sulphate, decolorizing, and reprecipitating.

ACTION AND USES.—Sabadilla is rarely used except for the extraction of veratrine. It is a powerful irritant and is sometimes used to kill vermin in the hair.

551. **POLYGONATUM.**—SOLOMON'S SEAL. The rhizome of **Polygona'tum biflo'rum** Elliott, and of **P. gigante'um** Dietrich. *Habitat:* North America. A pale brownish-yellow or whitish root, annulate and jointed, each joint being surmounted by an obscurely seal-like stem-scar, which gives to the plant its name; internally whitish, spongy; inodorous; taste sweetish, mucilaginous, with an acrid, bitterish after-taste. Tonic, mucilaginous and mildly astringent; formerly much used in skin diseases and as a vulnerary, and has been recommended in gout and rheumatism. Dose: 1 to 2 dr. (4 to 8 Gm), in fl'ext.

552. **CHAMÆLIRIUM LUTEUM** Gray.—HELONIAS DIOICA Pursh. FALSE UNICORN. *Habitat:* United States. The rhizome, which is the part employed, is greenish-brown externally, closely annulate, about 25 mm. (1 in.) long, and 6 mm. (¼ in.) thick, beset on the lower side with numerous wiry rootlets; internally whitish, horny; bitter. Transverse surface is dirty white in hue and of a horny texture, and exhibits a well-defined central column occupying about one-third the diameter. It has been used as an adulterant for sanguinaria. Tonic, diuretic, anthelmintic. Dose: 15 to 60 gr. (1 to 4 Gm.).

553. **TRILLIUM.**—BIRTHROOT. WAKE-ROBIN. The rhizome of **Trill'ium erec'tum** Linné, and other species of Trillium growing in the United States. Emmenagogue and emetic. Dose: 15 to 60 gr. (1 to 4 Gm.).

554. **ASPARAGUS.**—The rhizome of **Aspar'agus officina'lis** Linné. Cardiac sedative or palliative, diuretic, laxative. Dose: 30 to 60 gr. (2 to 4 Gm.).

FIG. 229.—Allium—Bulb and cross-section of same (twice natural size).

555. **ALLIUM.**—GARLIC. The bulb of **Al'lium sati'vum** Linné. Official in U. S. P. 1890. A compound, subglobular bulb, flattened at the base, pointed at the apex, where several inches of the stem remains; it consists of five or six (in commercial garlic about eight) small, oblong, somewhat curved bulbs or "cloves" arranged around the central axis, each with a distinct coat, and internally whitish, moist, and fleshy; the whole bulb is inclosed by a dry, white, membranous coat, consisting of several delicate laminæ; odor pungent and disagreeable (alliaceous); taste warm, acrid. Used in the fresh state. Commercial garlic is a hybrid between *A. sativum* and *A. porrum* Linné. *Constituents:* Mucilage 35 per cent., albumen,

fibrous matter, and moisture. The peculiar odor and taste are due to volatile oil, composed of the sulphide and oxide of allyl. Stimulant and expectorant, also diaphoretic and diuretic. Dose: 30 to 60 gr. (2 to 4 Gm.).

Syrupus Allii (20 per cent., with the addition of dilute acetic acid) (U. S. P. 1890) Dose: 1 to 2 fl. dr. (4 to 8 Cc.).

556. SCILLA.—Squill.

SQUILLS. *Ger.* MEERZWIEBEL.

The inner freshly scaled bulb of **Urgin'ea maritima** (Linné) Baker, cut into slices and dried, the central portions being rejected.

Botanical Characteristics.—*Bulb* semisuperficial. *Leaves* lanceolate, all radical, appearing after the flowers. *Scape* 2 to 4 feet high, terminated by a dense raceme of yellowish-green *flowers*, each one of which is accompanied by a long bract; *ovary* with 3 nectariferous glands at the apex.

Habits of Plant.—Grows in sandy places near the coast. The plant flowers in autumn, the leaves appear in the following spring. Bulb only half immersed in the soil.

Habitat.—Mediterranean shores, in dry, sandy places near the coast.

Description of Drug.—Squill comes into the market in **narrow horny segments** about 50 mm. (2 in.) long, often more or less contorted; color varying from **white or yellowish-white to a reddish tint,** slightly translucent; when dry, it is brittle and pulverizable, but by exposure to a moist atmosphere it becomes flexible. Occasionally vertical slices, sometimes adhering at the base, are met with. Odor slight; taste mucilaginous, bitter, nauseous, and acrid.

The fresh bulb is inversely pear-shaped, fleshy, varying in size from that of a man's fist to a child's head. There are two kinds, differing only in color, one being entirely white, and the other reddish-brown externally, internally rose color, with white parenchyma. In preparing for market the outer scales are removed and the bulb is then sliced transversely, the central scales being also rejected as being too fleshy and mucilaginous; they lose about four-fifths of their weight in drying.

Powder.—Pale yellowish-brown, darkens with age. Characteristic elements: Parenchyma cells, very large, thin-walled, with mucilage and raphides of calcium oxalate; varying from very small, fine needles to very large, acicular crystals.

Constituents.—Merck's analysis shows three active principles, **scillipicrin** (a bitter principle acting upon the heart), **scillitoxin,** glucoside (bitter, burning, also acting upon the heart), **scillin,** crystalline (producing numbness, vomiting, etc.), with mucilage, sugar, sinistrin, $C_6H_{10}O_5$, like dextrin, and calcium oxalate crystals. Later in-

vestigations point to the probability of the above principles being alkaloids, and they are named scillapicine, scillamarine, and scillamine respectively. Jamersted's scillain is a poisonous glucoside of a yellow color.

ACTION AND USES.—**Expectorant, diuretic,** in large doses emetic and

FIG. 230.—*Urginea scilla.*

cathartic. As an expectorant it is usually combined with tartar emetic or ipecac; as a diuretic, with stimulant expectorants. It is **very rarely given as an emetic** because of its uncertainty, having often proved fatal from its irritant action on the stomach and intestines, and by causing hypercatharsis, death occurring by arrest of the heart in systole. Dose: 1 to 3 gr. (0.065 to 0.2 Gm.).

OFFICIAL PREPARATIONS.

Acetum Scillæ (10 per cent.), ... Dose:	10 to 30 ♍ (0.6 to 2 Cc.)
Syrupus Scillæ (45 per cent. of the acetum), ...	30 to 60 ♍ (2 to 4 Cc.).
Tinctura Scillæ (10 per cent.), ...	5 to 20 ♍ (0.3 to 1.3 Cc.).
Fluidextractum Scillæ, ...	1 to 4 ♍ (0.065 to 0.25 Cc.).
Syrupus Scillæ Compositus (fl'ext. 8 per cent., with fl'ext. senega 8 per cent., and tartar emetic 2 per cent. or $\frac{1}{8}$ gr. to the teaspoonful),...........	15 to 60 ♍ (1 to 4 Cc.); 1 to 2 fl. dr. (4 to 8 Cc.).

COLCHICUM.—MEADOW SAFFRON.

The corm and the seed of **Colchicum Autumnale** Linné.

BOTANICAL CHARACTERISTICS.—*Col'chicum autumnal'e* Linné. *Corm* fibrous-rooted. *Leaves* about a foot long. *Flowers* several, lilac or purple, appearing in the autumn without the leaves; *styles* 3.

HABITAT.—Europe and North Africa.

HABIT OF PLANT.—Flowers in autumn; the leaves appear in the spring.

In the latter part of spring a new corm begins to form at the expense of the old one. In September the upper portion of the flower emerges from the spathe just above ground unaccompanied with leaves. The rudimentary fruit at the base of the flower, below ground, in the following spring rises upon a stem above the surface, in the form of a 3-celled capsule. At the same time the leaves appear; so that, in fact, the leaves follow the flower, instead of preceding it. During the development of the fruit the new corm has been developing at the expense of the old parent one. It will be seen that the medicinal virtues depend upon the time of collection. Early in the spring it is too young, and late in the fall the parent corm has become exhausted by the nutriment furnished to the new plant. The proper period for collection, therefore, is said to be from June to the month of August, although April roots have been found to be of superior efficacy.

557. COLCHICI CORMUS.—(CORM.)

COLCHICUM CORM. *Ger.* ZEITLOSENKNOLLEN.

The dried corm of **Col'chicum Autumnal'e** Linné, yielding by the official process not less than 0.35 per cent. of colchicine.

DESCRIPTION OF DRUG.—An ovoid corm about 25 to 40 mm. (1 to $1\frac{3}{5}$ in.) long, flattened and deeply grooved on one side; when dried and deprived of its outer membranous covering it is wrinkled and of a brownish-gray color; internally whitish. It often comes into market in **transverse starchy slices having a reniform outline,** due to

FIG. 231.—*Colchicum autumnale.*

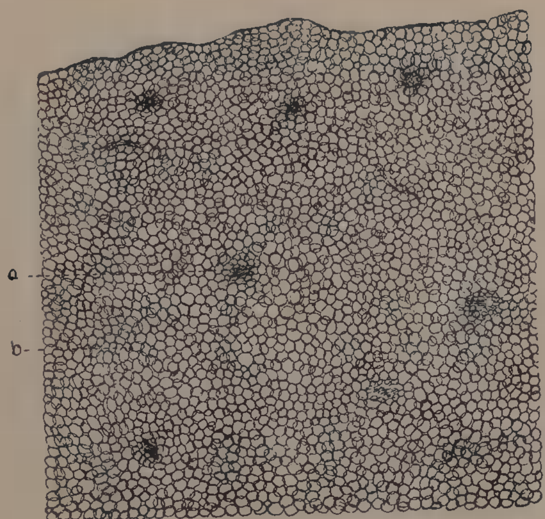


FIG. 232.—Cross-section of Colchicum root—outer portion. a, Vascular bundle. b, Parenchyma.

the lateral groove; inodorous; taste sweetish, bitter, and somewhat acrid. A very deep or large notch in the slices indicates that the corm has been partially exhausted by the offset which springs from the base.

Powder.—Brownish-gray, reddish-yellow with concentrated H_2SO_4. Characteristic elements: Parenchyma cells large, thin-walled, with starch spherical or ovoid (7 to 20 μ in diam.), simple or 2-3-4 compound; ducts, spiral, scalariform; trichomes, very few, tapering, one-celled.

CONSTITUENTS.—**Colchicine,** a methyl derivative of colchiceïn as will be seen from the following: Colchiceïn, $C_{15}H_9(NHCOCH_3)(OCH_3)_3COOH$; colchicine, $C_{15}H_9(NHCOCH_3)(OCH_3)_3COOCH_3$. With mineral acids colchicine yields colchiceïne and methyl alcohol. Starch, gum, resin, fat, and sugar are also present.

Preparation of Colchicine.—Exhaust with alcohol, dilute with water, filter; add lead subacetate to precipitate coloring matter; add sodium phosphate to remove lead; precipitate solution with tannin, wash the precipitate and digest with lead oxide, dry, and dissolve out colchicine with alcohol. Occurs in whitish amorphous powder or crystals; odor saffron-like, taste bitter.

ACTION AND USES.—Cathartic, emetic, and diuretic. It is chiefly employed in gout and rheumatism, in which it is very efficacious. Dose: 2 to 8 gr. (0.13 to 0.5 Gm.).

OFFICIAL PREPARATIONS.

Fluidext. Colchici Rad. (U. S. P. 1890), . Dose:	2 to 5 ♏ (0.13 to 0.3 Cc.).
Extractum Colchici Cormi, ...	1 to 3 gr. (0.065 to 0.2 Gm.).

558. COLCHICI SEMEN.

COLCHICUM SEED. *Ger.* ZEITLOSENSAMEN.

The seed of **Col′chicum autumnal′e** Linné, yielding by the official process not less than 0.55 per cent. of colchicine.

DESCRIPTION OF DRUG.—These seeds have the same constituents and the same medicinal action as the roots, and are given in about the same doses. They are hard, reddish-brown, subglobular, 3 mm. ($\frac{1}{8}$ in.) in diameter, somewhat pointed at the hilum and with a slight projection or caruncle on one side. Testa thin, somewhat scurfy, closely adhering to the white albumen, which fills the entire seed and which is characterized by its **extreme hardness;** embryo small, nearly opposite the hilum; inodorous; taste oily, bitter, and somewhat acrid. Dose: 3 gr. (0.2 Gm.).

Powder.—Light brown. Characteristic elements: Parenchyma of endosperm, thick-walled with simple pores and granules of proteid and oil globules; sclerenchyma with stone cells containing coloring-matter soluble in KOH solution.

OFFICIAL PREPARATIONS.

Vinum Colchici Seminis (10 per cent.), . Dose:	10 to 60 ♏ (0.6 to 4 Cc.).
Tinctura Colchici Seminis (10 per cent.), ...	10 to 60 ♏ (0.6 to 4 Cc.).
Fluidextractum Colchici Seminis, ...	1 to 5 ♏ (0.065 to 0.3 Cc.).

559. ALOE.—Aloes.

Ger. ALOE.

The inspissated juice of the leaves of **Aloe Perryi** Baker, **Aloe vera** (Linné) Webb, **Aloe Chinensis** Baker, and probably other species of Aloe.

Botanical Characteristics.—Succulent plants with spicate inflorescence; *perianth* tubular; *style* equal in length to the stamens, or almost wanting. *Capsule* membranous, scarious; *seeds* in two rows, flattened or 3-cornered, winged. *Habitat:* Island of Socotra in the Strait of Babelmandeb; Barbadoes; Cape of Good Hope, etc. The American aloe, or century plant (*Agave americana*), is a plant quite similar to the above.

Collection.—The bitter, yellow, succulent portion of the leaf (which, when inspissated, constitues the aloes of commerce) is found in thin-walled ducts near the surface. The thick leaves are cut off near the base (March and April) and stood up in the sun to drain upon skins (see *Aloes capensis*, 559 b). Impurities are removed by skimming with a ladle, etc. Artificial heat is sometimes used for evaporation. When of proper consistence, the evaporate is transferred to kegs, monkey skins, or boxes, and shipped by way of Bombay and Zanzibar.

Since the present pharmacopœia has required this drug to be assayed, the variety of aloes from which the drug is obtained is not so important. The commercial varieties formerly recognized were the Socotrine, Curacoa and Barbadoes, etc. The present pharmacopœia gives the following physical characteristics:

In yellowish-brown or orange-brown to blackish-brown opaque masses, or translucent in thin fragments, fracture uneven, dull and waxy, somewhat resinous, or smooth and glassy, somewhat conchoidal; occasionally exhibiting microscopical crystals of aloin; odor distinct; taste nauseous, bitter. It gives a reddish color with nitric acid or with solutions of alkalies.

Constituents.—The active principle of these different aloes is a bitter neutral principle having the general name of **aloin,** but slightly differing in each variety, forming possibly a homologous series; these aloes may be distinguished by their characteristic reactions with different reagents. It should be stated that the various processes of assay for aloes thus far proposed give discordant results. A small percentage of emodin is found in various varieties. Cape aloes contains 0.8 per cent. of this principle. For a review of the different commercial varieties, see "Proc. Amer. Pharm. Asso'n," 1903, p. 727.

559 **a. ALOE BARBADENSIS.**—Barbadoes Aloes. Prepared from the leaves of **Aloe vera** by boiling the juice or by making a decoction of the leaves; it is inferior to the other varieties. Its color varies, but it is usu-

ally **dark brown, approaching to black,** opaque even at the edges, **and** with a **dull fracture;** it is further distinguished by its **nauseous odor.** A solution of 1 part in 100,000 of distilled water produces a fine rose color on the addition of gold chloride or tincture of iodine, all the others, except Natal aloes, producing only a slow change, a feeble color, or no color whatever.

559 b. **ALOE CAPENSIS.**—CAPE ALOES or SHINING ALOES. Collected from **Aloe spic'ata** and other species, at Cape of Good Hope. A sheepskin is spread out in a shallow hole in the ground, the leaves arranged with their cut ends hanging over the edge, and the juice allowed to run out spontaneously; the juice is then inspissated in iron cauldrons or other vessels to a soft consistence, and poured into sheepskins or boxes to concrete. It differs from Socotrine aloes in its **glossy, conchoidal fracture and its peculiar, strong odor,** neither aromatic nor disagreeable. Moreover, a freshly broken surface has a dark **olive or greenish color, approaching to glossy black.** The powder is greenish-yellow, and often covers the surface of the lumps, giving them a somewhat yellowish appearance. Natal aloes is of a greenish-slate hue and has the odor of Cape aloes, distinguishing it from hepatic aloes.

559 c. **ALOES SOCOTRINA.**—SOCOTRINE ALOES. This variety was formerly official; of a yellowish or reddish-brown color; of a peculiar saffron-like odor.

559 d. **CURACOA ALOES.**—Formerly official, as synonymous with Barbadoes aloes.

TESTS.—A drop of nitric acid on a porcelain slab gives a vivid crimson with barbaloin (rapidly fading) and nataloin (permanent unless heat be applied), but has no effect on socaloin. To distinguish between barbaloin and nataloin they are treated with a drop or two of sulphuric acid and the vapor of nitric acid passed over them; barbaloin (also socaloin) will undergo no change, but nataloin will change to a blue color. Also resin, 50 to 30 per cent.; volatile oil, 0.0015 per cent.; ash, 1 per cent.

Preparation of Aloin.—From some varieties of aloes it is obtained by digesting in alcohol for twenty-four hours; then boil, filter, and set aside to crystallize. Can also be obtained by dissolving aloes (Barbadoes or Curaçoa) in acidulated boiling (HCl) water, and, when cold, resin will deposit; decant, evaporate, and set aside for two weeks, when aloin will crystallize. Shaking the crystals with acetic ether removes adhering resin. Dose: 2 to 5 gr. (0.12 to 0.32 Gm.). (See also 559 e.)

ACTION AND USES.—**Cathartic and emmenagogue.** As a cathartic aloes is slow in action but certain, having a peculiar affinity for the large intestine; it has produced beneficial effects as a cholagogue; as an emmenagogue it is extensively employed in amenorrhœa. Dose: 2 to 5 gr. (0.13 to 0.3 Gm.).

OFFICIAL PREPARATIONS.

Extractum Aloes, ... Dose:	3 to 10 gr. (0.2 to 0.6 Gm.).
Aloe Purificata, ...	2 to 5 gr. (0.13 to 0.3 Gm.); 8 to 15 gr. (0.5 to 1 Gm.).
Tinctura Aloes (10 per cent. with glycyrrhiza 20 per cent.), ...	5 to 10 ♏ (0.3 to 0.6 Cc.); ½ to 4 fl. dr. (2 to 8 Cc.).

Tinctura Aloes et Myrrhæ (10 per cent. of each, with glycyrrhiza 10 per cent.),	½ to 2 fl. dr. (2 to 8 Cc.).
Tinctura Benzoini Composita (2 per cent. of aloes), ...	10 to 40 ♏ (0.6 to 2.6 Cc.).
Extractum Colocynthidis Compositum (50 per cent.), ...	5 to 25 gr. (0.3 to 1.6 Gm.).
Pilulæ Catharticæ Compositæ, ...	2 to 5 pills.
Pilulæ Catharticæ Vegetabiles, ..	2 to 5 pills.
Pilulæ Aloes (about 2 gr. in each pill),	2 to 5 pills.
Pilulæ Aloes et Ferri (about 1 gr. each of aloes, dried sulphate of iron, and aromatic powder in each pill), ...	1 to 3 pills.
Pilulæ Aloes et Mastiches (2 gr. aloes in each pill, together with mastic and red rose), ...	2 to 5 pills.
Pilulæ Aloes et Myrrhæ (aloes 2 gr. in each pill, together with myrrh and aromatic powder), ...	2 to 5 pills.
Pilulæ Rhei Compositæ (aloes 1½ gr. in each pill), ...	1 to 3 pills.

559 e. **ALOINUM.**—ALOIN. A neutral principle from several varieties of aloes, chiefly Barbadoes aloes (yielding barbatorin), $C_{17}H_{20}O_7$, and Socotra or Zanzibar aloes (yielding socaloin), $C_{15}H_{16}O_7$, U. S. P. Nataloin, $C_{16}H_{18}O_7$, while not official, is a similar product. Minute acicular crystals, or a microcrystalline powder, yellow to yellowish-brown, of a slight odor and characteristic bitter taste. Barbaloin, soluble in 470 parts of ether; socaloin, soluble in 380 parts of ether. Both soluble in water and alcohol. It is rapidly decomposed in alkaline solution. Dose: 1 gr. (0.6 Gm.).

560. **XANTHORRHŒA.**—GUM ACAROIDES. BOTANY BAY RESIN. GRASS-TREE RESIN. A spontaneous resinous exudation from the stems of different shrubby Australian plants of the genus **Xanthorrhœa.** The yellow variety, from *X. hastitis* R. Brown, resembles gamboge in appearance; externally reddish yellow, internally a lighter yellow; odor agreeably balsamic, especially when heated, when it emits a tolu-like odor; taste balsamic, somewhat acrid. The red variety, from *X. australis* R. Brown, resembles dragon's blood in appearance, being externally deep brown-red; internally bright red; fracture glossy.

CONSTITUENTS.—Resin, benzoic and cinnamic acids, and a trace of volatile oil.

ACTION AND USES.—Resembles storax and tolu in medical properties. Dose: 8 to 30 gr. (0.5 to 2 Gm.). Chiefly used as a substitute for shellac, and for making colored varnishes.

561. **ERYTHRONIUM AMERICANUM** Smith.—ADDER'S TONGUE. DOG-TOOTH VIOLET. *Habitat:* United States. (Leaves.) Alterative. Sometimes applied as a poultice to scrofulous tumors.

PALMÆ.—Palm Family.

Synopsis of Drugs from the Palmæ.

A. *Seed.*
 Areca, 562
B. *Fruit.*
 SABAL, 563.
C. *Root.*
 Carnauba, 564.
D. *Resin.*
 Draconis Resina, 565.
E. *Fixed Oils.*
 Oleum Palmæ, 566.
 Oleum Cocois, 567.

562. **ARECA.**—ARECA NUT. BETEL NUT. The seed of an East Indian tree, **Are'ca cat'echu** Linné. Roundish-conical, about 25 mm. (1 in.) long, flat-

tened at the base; externally deep brown, varied with fawn-color, giving it a longitudinally-veined appearance; internally brownish-red with white veins. It abounds in tannin, and contains three alkaloids upon which its tæniafuge properties depend, arecoline, arecaine, and a trace of an undetermined alkaloid. Mixed with the leaves of *Piper betel* it forms the "betel" chewed so largely by the natives. It is strongly recommended as a tæniafuge and vermifuge. Dose: 2 to 3 dr. (8 to 12 Gm.).

563. SABAL.

SABAL. (SAW PALMETTO.)

The dried ripe fruit of **Sereno'a serrula'ta** (R. and S.) Hooker filius.

Irregularly spherical to oblong-ovoid; 10 to 25 mm. long, 10 to 15 mm. in diameter; externally blackish-brown, shrivelled, somewhat oily; epicarp thin, sarcocarp about 1 mm. thick, greenish-yellow, soft, spongy, endocarp thin, friable; seed hard, chocolate-brown; odor aromatic; taste sweetish, acrid and oily. Tonic, diuretic, expectorant, and sedative, used in neuralgic affections to allay irritation of mucous membranes, and in pulmonary affections. Dose of fl'ext.: $\frac{1}{2}$ to 2 fl. dr. (2 to 8 Cc.).

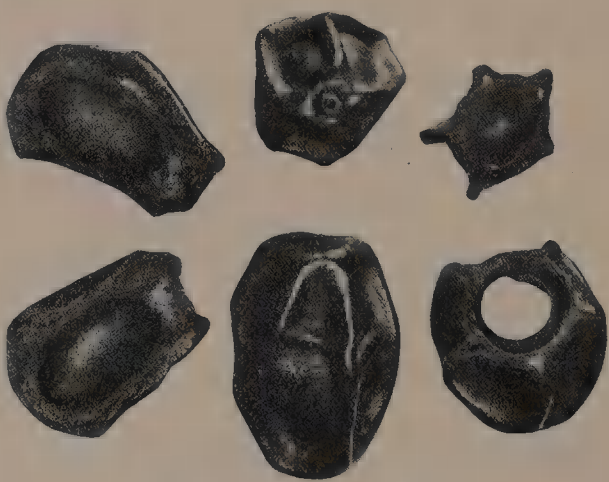


FIG. 233.—Sabal. Fruit. (Photograph.)

564. **CARNAUBA.**—The root of **Coper'nica cerif'era** Martius, used in Brazil, where the plant grows, as an alterative like sarsaparilla, stillingia, etc. Dose: 15 to 60 gr. (1 to 4 Gm.).

565. **DRACONIS RESINA.**—DRAGON'S BLOOD. A spontaneous resinous exudation from the ripening fruit of **Cal'amus dra'co** Willdenow. *Habitat:* East Indies, Siam, and the Molucca Islands. A dark brownish-red, internally brighter red resin, coming into market in various forms, small granules, oval pieces in bead-like strings, sticks, and the poorer varieties in cakes and disks; breaks with a dull, irregular fracture; tasteless and almost odorless, but when heated emits a benzoin-like odor, due to the benzoic acid which it contains. The red resin, constituting 90 per cent., has been termed draconin. The use of dragon's blood is almost entirely confined to the manufacture of paints and varnishes.

566. **OLEUM PALMÆ.**—Palm Oil. A fixed oil expressed from the fruit of **Elæ'is Guineen'sis** Jacquin, a West African palm cultivated in tropical America. A solid fat, harder than butter, of an orange-red color, bleaching upon exposure to light or heat. When fresh, it has a violet-like odor and a bland taste, but it rapidly becomes rancid and of an acrid taste. It is used principally in the manufacture of soaps and candles, occasionally in ointments.

567. **OLEUM COCOIS.**—Cocoanut Oil. A fixed oil expressed from the seeds of the tropical palm, **Co'cos nucif'era** Linné. A white solid, of the consistence of butter, and with a disagreeable odor. It is mostly used in soaps.

AROIDEÆ.—Arum Family.

Herbs with an exceedingly acrid, colorless juice, and having a fleshy corm or rhizome. *Inflorescence* a spadix usually surrounded by a spathe. *Fruit* a berry.

Synopsis of Drugs from the Aroideæ.

A. *Rhizomes.*	B. *Corms.*
CALAMUS, 568.	Arum, 570.
Symplocarpus, 569.	Arisæma Dracontium, 571.

568. CALAMUS.—Calamus.

SWEET FLAG. *Ger.* KALMUSWURZEL.

The dried rhizome of **Acor'us cal'amus** Linné (Fam. Araceæ, U. S. P. 1900.)

Botanical Characteristics.—Pungent, aromatic plants, with equitant, 2-ranked *leaves*. *Inflorescence* a spadix on a leaf-like scape, sessile, lateral, yellowish green; *sepals* 6, *stamens* 6, *anthers* 1-celled, with transverse dehiscence; *ovary* 2- to 3-celled.

Habitat.—North America, Europe, and Western Asia, in swamps, and along the banks of streams and ponds.

Description of Drug.—Subcylindrical sections of various lengths, about 20 mm. ($\frac{4}{5}$ in.) thick; externally reddish-brown, deeply wrinkled, marked below with rootlet scars (little elongated dot-like rings) in wavy, longitudinal lines, above with leaf-scars; fracture short, corky, showing a pinkish or whitish **interior** dotted with yellowish or brownish dots, both in the thick cortical layer and in the spongy central column; **odor** aromatic; **taste** peculiar, very bitter. Although the unpeeled rhizome is directed, **the pinkish-white sections** deprived of the corky layer are often met with in market.

Structure.—The tissue is chiefly parenchyma, traversed by yellowish fibrovascular bundles, most abundant just within and near the nucleus sheath. The cells of the parenchyma are filled with starch and volatile oil, the latter most abundant in the cortical layer. The spongy appearance of the meditullium is due to large air-cells, as in all aquatic plants.

CONSTITUENTS.—Volatile oil 1 to 2 per cent., having the smell and taste of calamus, a bitter glucoside termed acorin (syrupy, yellow liquid), calamine, choline, resin, starch, and mucilage.

Isolation of Acorin.—A concentrated decoction of the drug is deprived of gum by precipitating with alcohol. The liquid is then treated with lead sub-

FIG. 234.—*Acorus calamus.*

acetate. The lead is removed by H_2S. The resulting liquid, after neutralization, is shaken with chloroform, which leaves on evaporation a thin, yellow, aromatic liquid, acorin. This splits into oil and sugar by hydration; by oxidation the resin and acoretin are obtained.

ACTION AND USES.—Tonic and carminative, and a feeble aromatic stimulant. Dose: 15 to 60 gr. (1 to 4 Gm.).

OFFICIAL PREPARATION.

Fluidextractum Calami, ...Dose: 15 to 60 ♏ (1 to 4 Cc.).

569. **SYMPLOCARPUS.**—SKUNK CABBAGE. The rhizome and roots of an indigenous herb, **Symplocar'pus fœ'tidus** Salisbury, so called from the disagreeable odor (depending upon a volatile oil) which is emitted by all parts of the fresh plant, and by the dried rhizome when triturated. It has an acrid taste, but the acrid principle has not yet been isolated. Stimulant, antispasmodic, and narcotic, causing nausea and vomiting, together with vertigo, headache, and dimness of vision. It has been used in asthma, whooping-cough, nervous and convulsive affections, and hysteria; also in chronic catarrh, chronic rheumatism, and bronchial and pulmonary affections. Dose: 10 to 20 gr. (0.6 to 1.3 Gm.).

570. **ARUM.**—INDIAN TURNIP. The corm of **Arisæ'ma** (Arum) **triphyl'lum** Torrey (Jack-in-the-pulpit or wake-robin). *Habitat:* North America, in rich woods. Depressed-globular, about 25 to 50 mm. (1 to 2 in.) in diameter, covered with a loose, wrinkled, brown epidermis; it often comes into market in **white, starchy, transverse slices;** inodorous; **very acrid.** This acrid principle is volatile, the fully dried corm being nearly inert. Arum has been used as a stimulant to the secretions in asthma, whooping-cough, chronic catarrh, and rheumatism. Dose: 8 to 15 gr. (0.5 to 1 Gm.).

571. **ARISÆMA DRACONTIUM** Schott.—GREEN DRAGON. *Habitat:* United States, west to Kansas. (Corm.) Diaphoretic and expectorant in dry, hacking coughs attended with irritation. Dose of fl'ext.: 1 to 10 ♏ (0.065 to 0.6 Cc).

COMMELINACEÆ.—Spiderwort Family.

572. **COMMELINA.**—ASIATIC DAY FLOWER. From **Com'melina com'munis.** This plant has recently been brought to notice as one of medicinal value. It is claimed to have peculiar hemostatic and healing properties. An account of the plant and a report of a chemical examination of it is found in the "Am. Jour. of Pharm.," July, 1898, p. 321.

CYPERACEÆ.—Sedge Family.

573. **CAREX ARENARIA** Linné.—RED SEDGE. RADIX SARSAPARILLÆ GERMANICÆ. This sedge grows in the coast regions of Central and Northern Europe, where its rhizome is used as an alterative like sarsaparilla.

574. **ADRUE.**—GUINEA RUSH. The rhizome of **Cy'perus articula'tus** Linné, used in its native country to check vomiting and as a tonic. Dose of fl'ext.: 30 ♏ (2 Cc.).

GRAMINEÆ.—Grass Family.

A large order yielding the cereals (wheat, rye, etc.) and sugar cane, the source of most of the sugar of the market. The characteristics of the order are the *hollow stems* (culms), *flowers* in spikelets, and the *fruit*, a caryopsis.

Synopsis of Drugs from Gramineæ.

A. *Rhizome.*
 TRITICUM, 575.
B. *Root.*
 Vetiveria, 576.
C. *Sugar.*
 SACCHARUM, 577.
D. *Styles and Stigmas.*
 ZEA, 578.
E. *Fixed Oil.*
 Oleum Maydis, 579

F. *Starches.*
 AMYLUM, 580.
 a. Avenæ Farina.
 b. Sago.
 c. Tapioca.
 d. Taro.
 e. Triticum Vulgare.
 f. Oryza.
 g. Solanum Tuberosum.
 h. Canna.
 i. Maranta.
 j. Curcuma Leucorrhiza.

G. *Fruit.*
 Hordei Fructus, 581.
H. *Decorticated Fruit.*
 Hordeum, 581 a.
I. *Germinated Seeds.*
 Maltum, 581 b.

575. TRITICUM.—Triticum.

COUCH-GRASS. *Ger.* QUECKENWURZEL.

The dried rhizome of **Agropy'ron rep'ens** Beauvois, gathered in the spring and deprived of the roots.

Botanical Characteristics.—Creeping; *root-stocks* slender, numerous. *Spikelets* 4- to 8-flowered, glabrous; *glumes* 3- to 7-nerved; *rachis* glabrous; *leaves* flat.

Habitat.—Europe; naturalized and grows abundantly in North America.

Description of Drug.—Short, hollow sections from 3 to 6 mm. ($\frac{1}{8}$ to $\frac{1}{4}$ in.) long, and about the thickness and color of a straw; odorless; taste sweetish.

Constituents.—No active constituent has been discovered in couch-grass; it contains glucose, mucilage, malates, triticin (a gummy substance resembling inulin), and inosit.

Preparation of Triticin.—Obtained by exhausting powdered drug with water; neutralize with baryta; concentrate and precipitate with lead subacetate; remove lead; purify with charcoal; neutralize, concentrate, and precipitate with alcohol. It is an amorphous, white powder, inodorous, tasteless, deliquescent, and with HNO_3 is oxidized into oxalic acid.

Action and Uses.—Diuretic, demulcent. Dose: $\frac{1}{2}$ to 3 dr. (2 to 12 Gm.).

Official Preparation.

Fluidextractum Tritici,..............Dose: 1 to 4 fl. dr. (4 to 15 Cc.).

576. **VETIVERIA.**—Vetivert. The fibrous wiry roots of **Andropo'gon murica'tus** Retzius. *Habitat:* Eastern India. Tonic and stimulant, but mainly employed as a perfume in sachet powders, etc.

577. SACCHARUM.—Sugar.

CANE-SUGAR. *Ger.* WEISSER ZUCKER.

The refined sugar obtained from **Sac'charum officina'rum** Linné, and from various species or varieties of Sorghum, also from one or more varieties of **Be'ta vulga'ris** Linné (nat. ord. Chenopodiaceæ).

Source and Varieties.—The sugar cane is extensively cultivated in Africa, East and West Indies (especially Cuba), Brazil, and Southern United States, particularly Louisiana. The sugar beet is extensively cultivated in France and Spain, and has been introduced with varying success into some parts of the United States. Cane-sugar is also a constituent of the sugar maple; of the carrot and turnip; of cassia pulp, etc. The sugar in fresh fruit is mainly cane-sugar; by the action of the fruit acids, or a ferment, it is generally *inverted*, becomes uncrystalline, and influences polarized light in the opposite direction from that of cane-sugar, twisting the ray from right to left. Honey-

FIG. 235.—Spikelet of the Oat (*Avena sativa*). *gl.* Glumes. *ps, fs.* Paleæ or pales. *a.* Awn. *pl.* An abortive flower.

FIG. 236.—*Triticum vulgare* (Wheat). Plant and flowers (enlarged).

FIG. 237.—*Agropyrum repens.*

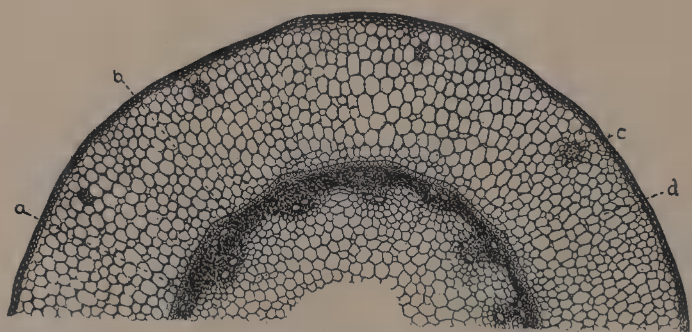


FIG. 238.—Cross-section of couch-grass. (25 diam.) a. Medullary parenchyma. b. Woody tissue. c. Wood-bundles. d. Cortical parenchyma.

sugar is probably a mixture of the two varieties—right- and left-handed. It is readily altered to a crystalline and granular mass of *grape-sugar* in dried fruit, as in the raisin, the prune, and solidified honey. This, the common form of grape-sugar, is right-handed, and is called dextrose (dextrogyrate), to distinguish it from lævulose. Barley-sugar is made by heating cane-sugar till it fuses, becoming thus, in a great measure, uncrystalline. Molasses (treacle)—*Syrupus fuscus* (official 1860–1870)—is the result from the evaporation of cane-sugar syrup; it is a mixture of cane-sugar with uncrystallizable sugar and coloring matter.

OTHER SUGARS.—Besides the modification above referred to, other sugars exist: as, galactose (milk-sugar)—*Saccharum lactis* (U. S. P.); mannose (from mannite); maltose (from starch by the action of dilute acid or diastase); melitose (from eucalyptus).

Caramel is a name applied to *burnt sugar* (*Saccharum ustum*), used in the liquid form as a coloring for spirits, vinegar, etc.

DESCRIPTION.—Sugar or sucrose, $C_{12}H_{21}O_{11}$, is in "white, dry, hard, distinctly crystalline granules, odorless, and having a purely sweet taste. Permanent in the air." The aqueous solution saturated at 15° C. (59° F.) has a sp. gr. of 1.345 and is miscible with water in all proportions, soluble in 175 parts of alcohol.

SACCHARUM UVEUM.—Grape-sugar. Glucose. Yellowish or whitish masses or granules much less sweet than cane-sugar. Composition $C_6H_{12}O_6H_2O$.

ACTION AND USES.—Demulcent and lenitive. Used in making the various syrups and compound syrups of the Pharmacopœia, etc.

578. ZEA.—ZEA.

CORN-SILK. *Ger.* MAISPISTILLE.

The dried styles and stigmas of **Ze'a ma'ys** Linné (our common Indian corn).

DESCRIPTION OF DRUG.—Yellowish or greenish, soft, silky, hair-like threads, about 150 mm. (6 in.) long; free from odor, with a sweetish taste.

CONSTITUENTS.—**Maizenic acid,** fixed oil, resin, sugar, gum, albuminoids, phlobaphene, extractive, salt, cellulose, and water.

ACTION AND USES.—Mild stimulant, diuretic. The infusion may be taken *ad libitum.*

Fluidextractum Zea (Unofficial) ......Dose: ½ to 2 fl. dr. (2 to 8 Cc.).

579. **OLEUM MAYDIS.**—MAIZE OIL. A fixed oil expressed from the embryo of the seed of **Zea mays** Linné. A yellow, viscid, transparent liquid, having a peculiar odor like cornmeal, and a bland taste. Demulcent.

580. AMYLUM.—Starch.

STARCH. *Ger.* STÄRKMEHL.

The starch grains obtained from the fruit of **Ze'a ma'ys** Linné.

Description.—Usually in opaque, angular or columnar masses, easily pulverizable between the fingers, with a peculiar sound, into a fine, white powder; odorless and tasteless. Under the microscope it is seen to be composed of small granules striated concentrically or

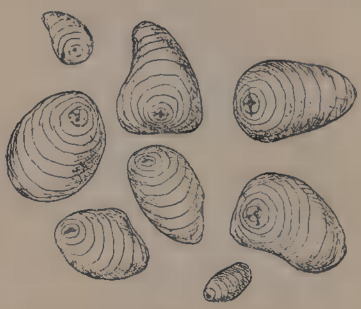


Fig. 239.—Maranta Starch.

Fig. 240.—Curcuma Starch.

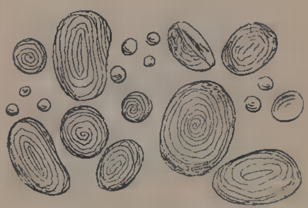


Fig. 241.—Wheat Starch.

Fig. 242.—Rice Starch.

Fig. 243.—Potato Starch.

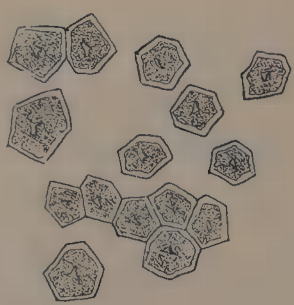


Fig. 244.—Corn Starch.

See also Starches of Drugs, part IV.

excentrically around a nucleus or hilum. Insoluble in cold water, but with boiling water it forms a glutinous paste on cooling. Iodine is the test for starch, the characteristic blue color being produced when only a minute quantity of the latter is present.

Other starches—chiefly distinguished by the size and shape of the starch-granules as seen under the microscope:

(*a*) AVENÆ FARINÆ.—Oatmeal. From *Avena sativa* Linné, probably native to Western Asia, but now a common field crop. A grayish-white, not uniform meal, containing the gluten and fragments of the integuments; bitterish. Demulcent and nutritive (due to the gluten contained).

(*b*) SAGO.—Pearl Sago. Globular, pearl-like grains, white or brownish, prepared from *Metroxylon sagu*, *M. rumphii*, and other species growing in the East India Islands.

(*c*) TAPIOCA.—Cassava Starch. Yielded by the rhizomes of Brazilian plants, *Manihot utilissima* and *M. aipi*, nat. ord. Euphorbiaceæ. White and opaque, irregular lumps.

(*d*) TARO.—Taro Flour. A starch prepared from the corm of *Colocasia esculenta* Schott, the food (poi) of the natives in Hawaii and the West Indies. Recommended as a diet for dyspeptic and consumptive patients.

Starches from the underground parts of *Triticum vulgare* and *Oryza sativa*, Gramineæ; *Solanum tuberosum* (potato starch), Solanaceæ; *Canna edulis*, *Maranta arundinacea*, and *Curcuma leucorrhiza*, Scitamineæ.

CHEMICAL COMPOSITION.—Starch is the basis of that class of organic compounds termed carbohydrates. Its composition is $C_6H_{10}O_5$. By hydrolysis it is converted into a gummy principle, dextrin, and glucose. Ferments convert it into alcohol and carbon dioxide—$C_6H_{10}O_5 = 2C_2H_5OH + 2CO_2$.

ACTION AND USES.—Nutritive and demulcent.

OFFICIAL PREPARATION.—

Glyceritum Amyli (10 per cent.).

581. **HORDEI FRUCTUS.**—BARLEY. The fruit of **Hor′deum dis′tichum** Linné, a common cultivated cereal indigenous to Western Asia. About 15 mm. ($\frac{3}{5}$ in.) long, tapering at the ends, on one side traversed by a longitudinal groove along which the grayish-yellow palea or husk is coalesced with the smooth, pale-brown testa; underneath the testa is a layer of gluten surrounding the central starchy parenchyma. Nutritive.

581 a. **HORDEUM,** or pearl barley, is the fruit deprived of its brown integuments.

581 b. **MALTUM.**—MALT Prepared from the fruit of **Hordeum distichum** Linné by soaking, and then allowing fermentation to proceed until the young embryo is nearly the length of the fruit; the fruit is then dried in the sun and afterward kiln-dried in order to kill the germ. The object of this process is to develop the greatest possible amount of diastase, a peculiar ferment which has the property of converting starch into sugar. Malt is demulcent and nutrient, given in the form of the extract, a brown liquid of honey-like consistence.

CRYPTOGAMS.

(Plants producing spores.)

EQUISETACEÆ.—Horsetail Family.

582. **EQUISETUM.**—SCOURING RUSH. The herb of **Equise'tum hyema'le** Linné. *Habitat:* Northern United States. Diuretic and astringent. Dose of fl'ext.: 15 to 60 ℳ (1 to 4 Cc.).

FILICES.—Ferns.

Leafy plants with the *fronds* raised on a stipe (petiole) rising from a rhizome, circinate in vernation. The *spore-cases* are found on the under side of the frond. The life history of the fern is as follows:

When the minute spore from the sporangium on the frond drops to the ground, it germinates into a more or less heart-shaped body called a prothallus. The under surface of this body is provided with root-hairs and also female organs of generation, archeogonia, and male organs, antheridia; the frond-stage is a direct outgrowth from the fertilized archeogonia.

Synopsis of Drugs from the Filices.

A. *Rhizome.*
   ASPIDIUM, 583.
B. *Herb.*
   Adiantum, 584.
C. *Hairs.*
   Cibotium, 585.
D. *Root.*
   Osmunda, 586.
E. *Leaves.*
   Polypodium, 587.

583. ASPIDIUM.—ASPIDIUM.

MALE FERN. *Ger.* WURMFARNWURZEL.

The dried rhizome of **Dryop'teris fil'ix-mas** Schott, and of **Dryop'teris margin-a'lis** Asa Gray.

BOTANICAL CHARACTERISTICS.—*Fruit-dots* round, borne at the back of the veins; indusium covering the sporangia. Stipe continuous with the root-stock. *Frond* lanceolate (*A. filix-mas*) or ovate-oblong (*A. marginalis*); fruit-dots in the former nearer the mid-vein than the margin, in the latter nearer the margin.

HABITAT.—North America.

DESCRIPTION OF DRUG.—As taken from the ground the rhizome consists of a caudex around which are arranged the dark brown, somewhat curved **leaf-stalk remnants or stipes,** about 25 to 50 mm. (1 to 2 in.) in length, imbricated like the shingles of a roof; at the base they are densely surrounded by **thin, glossy, chaffy scales** of a lighter color and somewhat transparent. The entire rhizome is from

100 to 300 mm. (4 to 12 in.) long, and from 50 to 62 mm. (2 to $2\frac{1}{2}$ in.) thick, flexible; it generally comes into market broken into pieces of various lengths; internally pale green, spongy or corky; odor slight and disagreeable; taste sweetish, somewhat bitter and astringent, acrid and nauseous. Only such portions as are still green should be

FIG. 245.—*Dryopteris filix-mas*—Plant and section through spore case.

used in making preparations. The deterioration of the root is rapid —loses its activity in one or two years.

MICROSCOPICAL STRUCTURE.—The prevailing tissue is parenchyma, the polyhedral, porous-walled cells of which contain starch, greenish or brownish tannin-like substances, and drops of a greenish fixed oil. The thin suberous outer layer consists of smaller brown cells.

Toward the center of the rhizome is an irregular circle of ten (*A. filix-mas*) or six (*A. marginalis*) vascular bundles, outside of which are smaller scattered bundles. Distributed throughout the tissue are large air pores.

FIG. 246.—Aspidium rhizome. (½ natural size.) A, Leaf-stalk. (Photograph.)

CONSTITUENTS.—**Filicic acid,** $C_{35}H_{42}O_{13}$, filicin (filicic acid anhydrid, $C_{35}H_{40}O_{12}$), aspidin, $C_{23}H_{27}O_7$, the latter being poisonous, fixed oil, a trace of volatile oil, and chlorophyll.

Preparation of Filicic Acid.—This principle is deposited as a granular sediment when the oleoresin is allowed to stand.

ACTION AND USES.—**Tæniafuge.** Dose: ½ to 2 dr. (2 to 8 Gm.). The oleoresin is the most efficient preparation.

OFFICIAL PREPARATION.

Oleoresina Aspidii, ...Dose: ½ to 1 fl. dr. (2 to 4 Cc.).

584. **ADIANTUM.**—MAIDENHAIR. **Adian'tum peda'tum** Linné, an indigenous fern which has been used as a pectoral in chronic catarrh and other affections of the air-passages.

585. **CIBOTIUM.**—PENGHAWAR. PAKU-KIDANG. The chaffy hairs collected from the base of the fronds and stems of many varieties of ferns, especially of the genus Cibotium, growing in Sumatra and Java. Long, silky, yellowish or brownish, curling filaments (under the microscope flat and jointed), used to stop the flow of blood from capillaries by mechanical absorption of the serum.

586. **OSMUNDA REGALIS** Linné.—BUCKTHORN BRAKE. A common fern in swamps, the root-stock of which is used as a demulcent, tonic, and styptic. Dose of fl'ext.: 1 to 3 fl. dr. (4 to 12 Cc.).

587. **POLYPODIUM.**—POLYPODY. The leaves of **Polypo'dium vulga're** Linné, common in Europe and North America. Expectorant in chronic catarrh and asthma. Dose: 1 dr. (4 Gm.), in infusion.

LYCOPODIACEÆ.—Club-moss Family.

Low plants looking like very large mosses, more or less branching, and with the 1- to 3-celled *sporangia* (spore-cases) in the axils of the lanceolate, subulate, or rounded, persistent *leaves*. *Spores* homogeneous.

588. LYCOPODIUM.—LYCOPODIUM.

VEGETABLE SULPHUR. *Ger.* GEMEINER BÄRLAPP.

The spores of **Lycopo'dium clava'tum** Linné, and of other species of Lycopodium.

BOTANICAL CHARACTERISTICS.—*Stem* creeping extensively, with ascending very leafy branches. *Leaves* linear-awl-shaped, aristate. *Spikes* 1 to 4 on a slender peduncle 4 to 6 inches long.

SOURCE AND COLLECTION.—Europe, Asia, and North America; collected mostly in Russia, Germany, and Switzerland, in July and August, by cutting off tops of the moss, shaking out spores, and sifting.

DESCRIPTION OF DRUG.—**A fine, pale-yellowish powder, very mobile,** free from odor and taste. It floats in water without being wet by it (due to the fixed oil), but sinks on being boiled. When slowly heated it burns quietly and should not leave more than 5 per cent. of ash, but when thrown into a flame it **flashes up.** Under the microscope the granules are seen to be tetrahedral, the basal side convex and the other three coming together to form a triangular pyramid. The surfaces are traversed in all directions by ridges which form regular, five- or six-sided meshes; at the points of intersection are small elevations, and along the edges short projections. Like lupulin, lycopodium is one of the interesting objects for microscopic study. Pollen

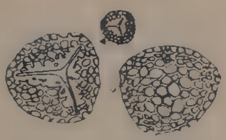


FIG. 247.—Spores of Lycopodium, as seen from the top and from bottom of the spore.

FIG. 248.—Lupulin; a gland viewed in profile and viewed obliquely. See Lupulinum, 497, p. 397.

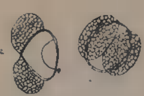


FIG. 249.—Pollen of Pine: a grain seen in profile; another seen from the front side.

of pine, an illustration of which is shown above, is sometimes used as an adulterant.

ADULTERANTS.—These may be easily detected by the microscope or simple tests. Pine pollen consists of an elliptical cell with a globular cell attached to each end. Starch is detected with iodine; turmeric, by turning reddish-brown with alkalies; inorganic mixtures, by increasing the yield of ash over 5 per cent., and by sinking in carbon disulphide. Dextrin has been found in lycopodium to the extent of 50 per cent.

CONSTITUENTS.—**Fixed oil 47 to 50 per cent.,** volatile bases in very small quantity, and ash containing alumina and phosphoric acid.

ACTION AND USES.—Absorbent and protective application to excoriated surfaces; in pharmacy, to facilitate the rolling of pill masses, and to prevent the adhesion of the pills.

POLYTRICACEÆ.

589. **POLYTRICHUM JUNIPERUM** Hedwig.—HAIR-CAP MOSS. This common moss is a powerful diuretic; in full doses given at very short intervals it has proved very beneficial in dropsy. Dose: 1 to 2 dr. (4 to 8 Gm.), in infusion.

LICHENES.

Consisting mainly of a thallus (often leaf-like), without stem and leaves, wholly cellular. Reproduced by spores.

590. **CETRARIA.**—ICELAND MOSS. The entire plant, **Cetra'ria islan'dica** Acharius. Off. U. S. P. 1890. The crisp, leaf-like lobes are cartilaginous, whitish on the under surface, channeled and fringed at the margins. A strong decoction gelatinizes on cooling; taste mucilaginous and bitter. The Pharmacopœia calls attention to the fact that the drug is frequently mixed with pine leaves, moss, and other lichens; from these it should be freed. *Constituents:* It is largely composed (70 per cent.) of **lichen starch,** lichenin, and isolichenin, a solution of the latter producing a blue color with iodine. Unlike the gum of chondrus, it furnishes but a trace of mucic acid when treated with nitric acid. Boiling with dilute acids converts the

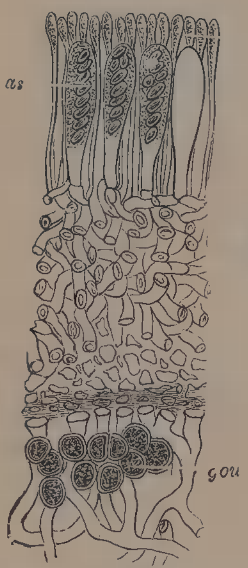


FIG. 250.—Section of thallus of *Cetraria islandica* through an apothecium. *as.* Asci, three of which contain ascospores. *gou.* Gonidia.

FIG. 251.—*Cetraria islandica.*

mucilage into sugar solution. A solution of Iceland moss is precipitated by alcohol. The bitter principle, cetraric acid (cetrarin, $C_{18}H_{16}O_8$), forms yellow salts, which are equal in bitterness to quinine; this bitter principle may be removed by prolonged maceration in water, or, still better, by treating the drug with twenty-four times its weight of a weak solution of an alkaline carbonate. Demulcent, nutritive, and, if the bitter principle be present, tonic; used in advanced stages of phthisis when stronger remedies are unsuitable. Dose: 30 to 60 gr. (2 to 4 Gm.).

Preparation of Cetrarin: Boil drug with alcohol; express and add acidulated (HCl) water to the filtrate; then allow cetrarin to deposit.

591. **LITMUS.**—A fermented coloring extract from various species of lichens (*e. g.*, *Lecanora tartarea*), other varieties of which also yield the dyes orchil and cudbear. *Habitat:* Northern Europe and African coast, and adjacent islands. Litmus is in about $\frac{1}{2}$ to 1 inch rectangular cakes, blue, light, friable, finely granular. Unlike most vegetable dyes, it is not turned green

by alkalies. It is turned red by acids, for which it is used as a test in the form of infusion (tincture), or litmus paper, made by dipping unsized paper in the strong infusion.

Orchil is a purplish-red, thickish liquid, with an ammoniacal odor.

Cudbear is a purplish-red powder, sometimes used to color preparations.

FUNGI.

Spore-bearing plants destitute of chlorophyll and reproduced by means of spores, not by true seeds.

592. ERGOTA.—Ergot.

ERGOT. (Ergot of Rye.) *Ger.* MUTTERKORN.

The sclerotium of **Clav′iceps purpu′rea** Tulasne (Fam. Hypocreaceæ U. S. P. 1900), replacing the grains of rye, **Secale cereale** Linné (Gramineæ), moderately dried, preserved with a few drops of chloroform and not kept longer than one year.

Development.—Sclerotium described: The early stage of the fungus consists of a profuse growth of *mycelium* in the tissues and upon the surface of the young ovary. In the "*sphacelia*" stage, as it is called, a multitude of *conidia* (non-sexual spores) are produced on the ends of the *hyphæ;* after the conidial stage the *mycelium* at the base of the ovary becomes greatly increased and assumes a hard and compact form. It grows with considerable rapidity, and carries upon its summit the old sphacelia and the remains of the now destroyed ovary. The compact, horn-shaped, dark-colored body which results (and is official) is called the *sclerotium*, which occupies the position of the displaced ovary. This sclerotium remains dormant in winter, and in the spring produces spores, as follows: stalked receptacles (Fig. 253) grow up from the tissue of the ergot, in which are developed a number of *perithecia* (Fig. 254) These *perithecia* are somewhat flask-shaped cavities (Fig. 255) filled with *asci* (Fig. 255), the latter containing long, slender spores termed *ascospores* (Fig. 256), which again, by germinating on the rye and other grasses, give rise to a new growth, and to the development of *Claviceps.*

Source.—Produced in the inflorescence within the paleæ of rye, *Secale cereale* Linné. Other grasses, however, are "hosts" for this fungus. Commercially, the Russian ergot is considered of superior strength, although Austrian, Spanish, and German (Bavarian) are thought to be almost equal in power. Swedish ergot seems to contain the lowest percentage of an active alkaloid, cornutine. Beckurts recommends that artificial heat be not employed in drying. The drug should be dried over quicklime without the application of heat.

Description of Drug.—The official ergot of rye is from 10 to 30 mm. ($\frac{2}{5}$ to $1\frac{1}{5}$ in.) long and from 2 to 6 mm. ($\frac{1}{12}$ to $\frac{1}{4}$ in.) in diameter. On other grasses it is usually of less size. Triangular, slightly curved, tapering toward, but obtuse at, the ends; externally purplish-black, internally whitish with pinkish lines; fracture short (not very brittle).

FIG. 252.—*Claviceps purpurea*. *A*. Young sclerotium, *c*, with old sphacelia, *s*. *p*. The apex of the dead ovary of rye. *B*. Upper part of *A*, in longitudinal section, showing sphacelia, *s*. *C*. Transverse section through the sphacelia, more highly magnified. *m*. The mycelium, surrounded with the hyphæ. *b*. Bearing conidia. *p*. Conidia fallen off. *w*. The wall of the ovary. *D*. Germinating conidia, forming sporidia, *x*.—(*Bachs*.)

FIG. 253.—Portion of Horn-shaped sclerotium of *Claviceps purpurea*, bearing four stalked receptacles.

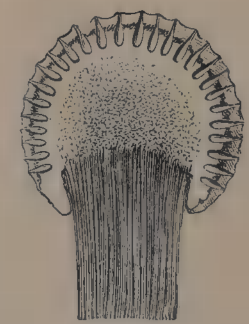


FIG. 254.—Longitudinal section of a receptacle, magnified, showing the perithecia.

FIG. 255.—A single perithecium of *Claviceps purpurea*, magnified, showing the contained asci.

FIG. 256.—Asci containing the long, slender ascospores.

If a portion be macerated in water containing hydrate of potassium or sodium, then carefully crushed under the blade of a spatula, the fragments of mycelium threads are plainly discernible under the microscope. Odor (especially in powder or when treated with an alkali) heavy and unpleasant; taste oily and disagreeable.

As the drug is liable to the attacks of insects, it should be protected in closed vessels, and a few drops of chloroform should be dropped upon it from time to time.

When more than one year old, it is unfit for use. Old ergot, which breaks with a sharp snap, is almost devoid of pinkish tinge upon the fracture, is hard and brittle between the teeth, and is comparatively odorless and tasteless, should be rejected.

Powder.—Dark gray, with purplish tint. The predominating elements are: The mycelium threads containing small fragments of hyphæ with fat, no starch.

CONSTITUENTS.—Notwithstanding the many investigations concerning the constituents of ergot, there still remains an uncertainty with regard to the nature of the so-called active principles. This is due partly to the fact that these principles are amorphous (?), and difficult to isolate and purify. For therapeutic purposes, however, it is sufficiently well established that the active principles are soluble in aqueous, alcoholic, or alkaline menstrua. Ergotinine, a crystalline principle (0.1 to 0.26 per cent.), is said to be present. Cornutine (see below) is probably a decomposition product of the former.

Assay of Ergot.—The physiological test for ergot, originated by E. M. Houghton, consists in feeding the preparation or drug to roosters, and noting the blackened and gangrenous appearance produced in the comb and wattles. The rapidity with which this change takes place and the depth of color produced denote the strength of the drug. According to Keller's investigation, ergot contains but one single base, Kobert's cornutine. Tanret's ergotinum, Dragendorff's and Podwyssotzki's picrosclerotine are all identical, or somewhat altered forms of the same substance. Jacoby finds *chrysotoxin* to fully represent ergot pharmacologically, and it retains its activity for years. This is one of the constituents of a complex body formerly named sphacelotoxin, or spasmodin. An assay of the drug can be made by estimating the proportion of *cornutine* present, which, according to Beckurts, is as follows: 25 Gm. of the drug are freed from oil by percolation with petroleum spirits, then dried and well shaken with 100 Gm. of ether and 1 Gm. of magnesia, the latter having been suspended in 20 Cc. of water. After repeated agitation the mixture is allowed to stand for three or four hours. Then 60 Gm. of the clear ethereal solution (to 15 Gm. of ergot) are shaken four successive times with 25, 10, 10, and 10 Cc. of dilute HCl (0.5 per cent.), the united solutions rendered alkaline by NH_4OH, and the alkaloid shaken out with three successive portions of ether. On evaporation, drying, and weighing the somewhat crystalline yellowish-white cornutine the assay is completed.

Preparation of Ergotin (Wiggers).—Treat ergot with ether to deprive it of fixed oil, then extract with hot alcohol, evaporate, and purify. It resembles cinchonic red, is soluble in alcohol, but insoluble in ether and water. Bonjeau's ergotin corresponds to a purified extract of ergot (aqueous extract, precipitated by alcohol, filtered, and evaporated); is soluble in alcohol and water.

ACTION AND USES.—Produces vascular contraction, especially of the arteries, all over the body. This property is said to be due to its action on the vasomotor centers in the cord. Because it contracts the arterioles it is hemostatic. The flow of urine is also diminished. It is **ecbolic and parturient,** powerfully exciting the pregnant uterus and expelling its contents. Recently it has been discovered to be of value in the treatment of insomnia, the sleep produced being more natural than that from other drugs. Dr. Livingstone reports its remarkable curative effects in a host of diseases. (N. Y. Med. Society, "Am. Druggist," 1903, p. 252.)

Poisonous symptoms: dimness of vision, local anesthesia, and numbness are sometimes produced, even by medicinal doses. Antidotes: evacuants (stomach-pump, emetics, etc.), stimulants, nitrite of amyl, inhalations, friction, etc. Dose: 20 to 30 gr. (1.3 to 2 Gm.) in freshly prepared powder, wine, or fluidextract; ergotin solution, 1 to 3 gr. (0.65 to 0.2 Gm.).

OFFICIAL PREPARATIONS.

Extractum Ergotæ, ...Dose:	3 to 12 gr. (0.2 to 0.8 Gm.).
Fluidextractum Ergotæ, ...	½ to 2 fl. dr. (2 to 8 Cc.).
Vinum Ergotæ (20 per cent.), ...	1 to 4 fl. dr. (4 to 15 Cc.).

593. **USTILAGO.**—CORN SMUT. A fungous growth upon **Zea mays,** more particularly upon the inflorescence. Consists of blackish, irregular, roundish masses enveloping innumerable spores; of a disagreeable odor and taste. It contains probably sclerotic acid. Used as a parturient and emmenagogue. Dose: 15 to 30 gr. (1 to 2 Gm.).

594. **AGARICUS ALBUS.**—LARCH AGARIC. PURGING AGARIC. WHITE AGARIC. From **Polypo'rus officina'lis** Fries. The internal, decorticated portion of the fungus comes in light, colorless, spongy masses of irregular shape. Taste sweetish, acrid, and bitter. In large doses cathartic. In doses of 8 gr., gradually increased to 1 dr., it has been found useful in checking night-sweats of phthisis. Surgeon's agaric, from *Polyporus fomentarium* Fries, is used externally as a styptic in hemorrhage.

594 a. **FUNGUS CHIRURGORUM.**—Surgeon's Agaric. Same as Polyporus. See above.

595. **TORULA** (*Saccharomyces*) **CEREVISIÆ,** an organized ferment. Yeast is the name applied to the frothy scum that forms on the surface of saccharine liquids and rises from the bungholes of newly brewed beer. Under the microscope this froth is shown to consist of particles which multiply with extraordinary rapidity when placed in a moderately warm temperature. The globular forms are considered as the spores of a fungus belonging to the genus *Torula*, the cells of which are but slightly united, sometimes forming branching chains, the mycelium being almost absent. Yeast is employed in hastening the fermentation of worts and in leavening dough in bread-making. Bottom or sediment yeast is found on the bottom of fermenting vessels. Two quite distinct methods of brewing are produced, depending upon the employment of one or the other of these varieties of yeast. For the purpose of the bakery, yeast is dried and formed into cakes. Beer yeast is official in the B. P. Yeast, under the title of fermentum, was official in the U. S. P., 1820–'40, 1860–'80, used as a tonic, laxative, etc., but at present rarely employed. As a local remedy, as poultice, in treatment of eruptions of boils, it still finds some favor.

ALGÆ.

Structure very various, growing for the most part in water, mostly in stagnant water in warm climates, but some on moist rocks or ground, etc. Entirely cellular, producing fronds.

596. CHONDRUS.—Irish Moss.

CARRAGEEN. *Ger.* PERLMOOS. KNORPELTANG.

The dried plant **Chon′drus cris′pus** Lyngbye. (Fam. Gigartinaceæ U. S. P. 1900.)

Botanical Characteristics.—*Thallus* fleshy, cartilaginous, compressed, dividing into short, moniliform filaments. *Antheridia* or *oogonia* in superficial spots. *Chondrus crispus* has four vessels or capsules imbedded in the frond. *Gigartina mamillosa* (*Chondrus mamillosa*) has an oval one raised upon a short stalk, and its frond is slightly channeled toward the base.

Source.—These plants inhabit the rocks on the American and European shores of the Atlantic Ocean. In the spring they are collected on the coast of New England and Ireland, the Massachusetts coast yielding about 15,000 barrels annually.

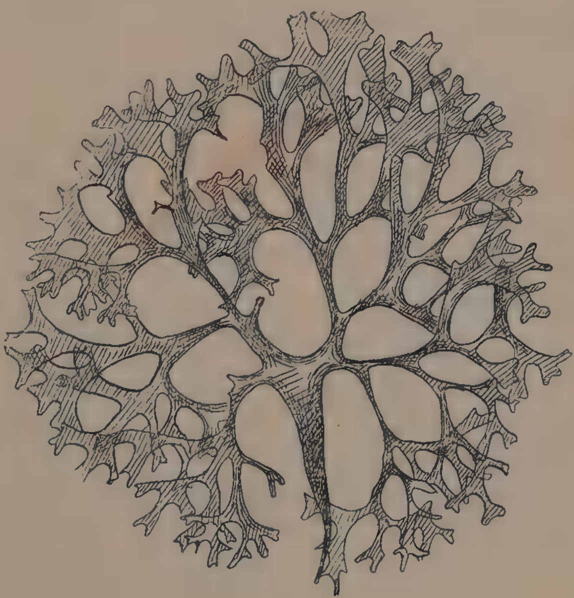


Fig. 257.—*Chondrus crispus.*

Description of Drug.—Yellowish or white, horny, translucent; many times forked; when softened in water, cartilaginous; shape of the segments varying from wedge-shaped to linear; at the apex emarginate or 2-lobed. It has a slight seaweed-like odor, and a mucilaginous, somewhat saline, taste.

ACTIO. One part of it boiled for ten minutes with thirty parts of water yields a solution which gelatinizes on cooling, and is not colored blue by Iodine T. S. Drug is said to be sometimes adulterated with other species of Gigartina, as *G. acicularis* and *G. piscillata*, which closely resemble the official species.

CONSTITUENTS.—The principal constituent (90 per cent.) is **mucilage,** which is precipitated by lead acetate; traces of iodine and bromine have also been detected. There seems to be no starch present, but the cell-walls acquire a dark blue color in contact with iodine (Flückiger). Literature rather contradictory as to the nature of its various constituents.

ACTION AND USES.—Demulcent and slightly nutritious. A dietetic is specially prepared from the powder, made in the form of jelly with water. Dose: 6 dr. (24 Cc.) in decoction.

RELATED DRUGS.—There are several edible seaweeds of East Indies which are known as agar agar, or Chinese (or Japanese) isinglass or gelatine, derived chiefly from *Gelidium corneum*, Lamarck. The article comes in long strips of yellowish-white color. A jelly from this is employed in bacteriological investigations.

597. **FUCUS VESICULOSUS.**—BLADDER-WRACK. The whole plant, **Fu'cus vesiculo'sus** Linné, growing on muddy rocks and floating to the shores of the North Atlantic and North Pacific Oceans, consists of long, flattened, branched fronds, upon which are dispersed blackish air-vessels (tubercles) in pairs, one on each side of the midrib. These cavities contain thin, gelatinous matter, and bear on their inner walls, when young, hair or transparent filiform cells. Odor marine-like; taste mucilaginous and saline. "Wracks" or rock weeds of other species are also collected, such as *Fucus nodosus* The medicinal properties probably lie in the inorganic matter, the ash of the plant containing chlorides, bromides, iodides, phosphates, and sulphates; the organic matter is mainly mucilage. The medicinal value of the drug as an alterative has been questioned; it is used in obesity. "The fl'ext. and extract are irrational preparations, the only form in which to obtain the effects of the plant being the recent decoction (Shoemaker)."

598. **LAMINARIA.**—SEA-GIRDLES or TANGLES. From **Lamina'ria digita'ta** Lamouroux. A dark-spored seaweed having a ribless expansion resembling a leaf-blade. The stipitate portion has been used in gynecology as a substitute for sponge in making sponge tents for dilating the cervical canal. Contains salts, mucilage, and mannite; the latter principle is especially prominent in another species,—*Laminaria saccharina*,—like the above, abundant on the sea-coast.

SECTION II.—ANIMAL DRUGS.

599. CANTHARIS.—CANTHARIDES.

SPANISH FLIES. BLISTER BEETLES. *Ger.* CANTHARIDEN.

The beetle, **Can'tharis vesicato'ria** De Geer. (Fam. Coleoptera.) Thoroughly dried at a temperature not exceeding 40° C. (104° F.).

HABITAT.—Southern and Central Europe and Northwestern Asia, feeding on plants of the families Oleaceæ and Caprifoliaceæ.

COLLECTION.—By shaking or beating the food-plants; the insects are then killed by heat (hot water) and rapidly dried.

DESCRIPTION.—A bronze-green beetle, with long (about 1 in. or 25 mm.) and narrow (¼ to ⅓ in., about 7 mm.), subcylindrical body. The vertical, rather triangular, head is constricted behind so as to form a conspicuous neck. Odor strong and disagreeable, caused, in the living insect, by a secreted fluid containing uric acid, according to Maquetti. The crushing of the dried insect yields a grayish-brown powder containing green shining particles (the bits of the green wing-covers and the body-wall).

FIG. 258.—Spanish Fly (*Cantharis vesicatoria* DeGeer)—(*Original*).

Cantharides should be thoroughly dried at a temperature of 40° C. (104° F.) and kept in tightly closed vessels. The dried insects or the powder is subject to the attacks of several Dermestid beetles and of several mites (*Glyciphigus*). The addition of a little chloroform, oil of turpentine, or naphthalene balls will help to keep out these cantharid-eating pests; or, if they have established themselves in the vessels, they may be killed by the use of carbon disulphide. (See Part III.)

OTHER SPECIES.—Besides *Cantharis vesicatoria*, several other beetles of the family Meloidæ, especially species of **Mylabris, Epicauta,** and **Macrobasis,** are used to obtain vesicatory agents, and give a larger percentage of cantharidin than the officially recognized insect.

Epicauta vittata.—The Old-fashioned Potato Beetle.* Found, often abundantly, in the United States; feeds largely on leaves of potato-plants. This insect was formerly official.

Mylabris cichorii Fab., and **M. phalerata** Pallas.—Chinese Blister Beetles. *Habitat:* Southern and Eastern Asia. *Cichorii* has its black wing-covers crossed by three broad orange-yellow bands; one band is terminal, thus rendering the apices of the wing-covers yellow.

Mylabris bifasciata.—The Two-striped Blister Beetle. *Habitat:* Northern Africa. The body is black, the wing-covers presenting two undulating narrow yellowish stripes. All these species of *Mylabris* yield about 1 per cent. of cantharidin.

ADULTERATION.—Spanish flies exhausted of their vesicating principle have been met with as substitutions. Powdered euphorbium has been spoken of as one of the adulterants, but adulteration is not common in this drug. The assay of the drug is very easily accomplished by making first a chloroformic solution of the soluble ingredients. Evaporating the chloroformic solution, the residue, containing the crystals, is purified by washing out the fat by means of carbon disulphide, which leaves the crystals of cantharidin pure. Other processes have been suggested, but the above seems to be the simplest.

FIG. 259.—Old-fashioned Potato Beetle (*Epicauta vittata* Fab.)—(*Original*).

CONSTITUENTS.—The chief constituents are: (1) cantharidin, the active principle, a fatty crystallizable body forming shiny, colorless plates, soluble in alcohol, ether, acetic ether, glacial acetic acid, chloroform, and oils; volatilizable by heat (100° C., 212° F.) without decomposition, the vapor condensing in acicular crystals; (2) a volatile oil, giving the odor of cantharides, and said to have vesicatory properties; and (3) a green oil, the coloring principle, closely allied to chlorophyll.

Preparation of Cantharidin.—Obtained by percolating the powder with chloroform, distilling off the liquid, and purifying the resulting crystals by washing them with CS_2 to remove fat. Colorless prisms; soluble in alcohol, ether, fats, etc.

* This "Potato Beetle" should not be confused with the well-known Colorado Potato Beetle (*Doryphora decemlineata*, Say), belonging to the family Crysomelidæ, a short, oval, yellow-and-black insect with ten longitudinal stripes on its wing-covers. This latter beetle probably possesses no vesicatory principle.

Cantharidin is associated with certain alkalies and alkaline earths in the drug, and seems to exist partly in combination with them. The principle itself has been found to combine with salifiable bases like an acid.

ACTION AND USES.—Internally cantharides acts as a powerful irritant, and has a peculiar effect on the urinary and genital organs. Large doses produce violent strangury, attended with excruciating pain and a discharge of bloody urine. The principal use of cantharides is the application, externally, of the cerate as a blistering plaster. It is seldom used as a rubefacient, but as an epispastic or vesicant it is to be preferred of all substances of this class. Its blistering action terminates in a copious secretion of serum under the cuticle. Dose: $\frac{1}{2}$ gr. (0.03 Gm.).

OFFICIAL PREPARATIONS.

Ceratum Cantharidis (32 per cent.).
Collodium Cantharidatum (60 per cent.).
Tinctura Cantharidis (10 per cent.), . . Dose: 1 to 5 ♏ (0.065 to 0.3 Cc.).

600. COCCUS.—COCHINEAL.

COCHINEAL BUG. RED SCALE INSECT. *Ger.* SCHARLACHWURM.

The dried female insect, **Coc'cus cac'ti** Linné. (Fam. Hemiptera.) Meloidæ.
X Pseudococcus

HABITAT.—Mexico, Central America, and Northern South America (originally), and Spain and Algiers (introduced); feeds on various cacti, especially upon *Opuntia coccinilifera.*

COLLECTION.—Only the females (wing less) are used; they are brushed off from the food-plant, and, if alive, are killed by heat (hot water or oven). The cochineal insect is cultivated on a large scale, and large quantities are annually exported from Mexico and Peru. Humboldt estimated that 800,000 pounds of coccus (each pound representing 70,000 insects) were annually imported into Europe.

FIG. 260.—Cochinea Bug (*Coccus cacti*) Linné (*Original*).

DESCRIPTION.—The females (which alone are used) are small, wingless, oval, dull purplish-brown insects, convex above, about 4 mm. ($\frac{1}{6}$ in.) long, covered, when alive, with a white cottony secretion. When the insects are dead and dry, this "cotton" rubs off, and the crushed insects yield a dark red powder; odor faint, taste slightly bitter.

VARIETIES.—These are: (1) silver, recognized by the presence of a soft, silvery white powder contained in the furrows and wrinkles; it appears

to be a fatty substance as it melts on the application of heat, and the insects lose their silvery appearance. This variety is said to be the mature and fecundated insect. (2) Black cochineal, of a reddish-black color, nearly devoid of silvery powder, is supposed to be the female exhausted by propagation. (3) Granilla, an inferior kind composed of small and imperfect insects.

ADULTERATION.—The silvery gray variety with carbonate or sulphate of barium and lead; the black cochineal with graphite, ivory black, or manganese dioxide. The fixed inorganic substances may be detected by the U. S. P. test, which is as follows: "When completely incinerated, cochineal should leave not more than 5 per cent. of ash."

CONSTITUENTS.—Cochineal contains principally a red coloring matter soluble in water, alcohol, or water of ammonia. This coloring matter is composed of carminic acid, $C_{17}H_{18}O_{10}$ (?).

Carminic acid is obtained by treating the drug first with ether to remove fat, then with alcohol. Let alcoholic solution stand a few days, when carminic acid will deposit as a brownish-purple substance. A vermilion-red powder (carmine), soluble in water, alcohol, and alkalies, is obtained as a combination of this acid with alumina or occasionally with oxide of tin or with albumen. Commercial carmine is made by precipitating the decoction of cochineal with alum or cream of tartar.

MEDICAL PROPERTIES.—Cochineal has some reputation as an anodyne and antispasmodic, but it has not for many years been used as a remedial agent, its chief use being that of a coloring matter, and for this purpose it enters into the following preparation.

OFFICIAL PREPARATION.

Tinctura Cardamomi Composita (0.5 per cent.), . . Dose: 1 fl. dr. (4 Cc.).

601. **BLATTA.**—COCKROACH. **Periplane'ta orienta'lis** Linné. Class, Insecta; order, Orthoptera; family, Blattidæ.

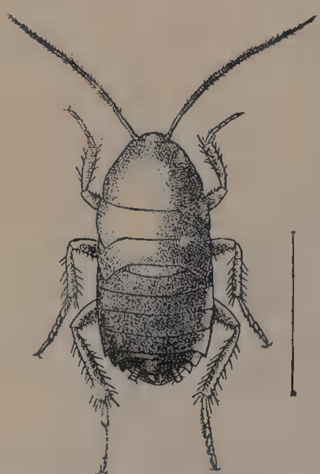


FIG. 261.—Cockroach (*Periplaneta* sp.)—(*Original*).

HABITAT.—Asia (originally); now found in almost all parts of the world, in kitchens, laundries, and any warm, damp room. Nocturnal in habit, feeding omnivorously on vegetable and animal products.

DESCRIPTION.—A large (1 in. long), dark brown, short-winged, broad, flat, oval insect with long, thread-like antennæ. Wings of the female rudimentary; of the male not reaching quite to the tip of the abdomen. Odor disagreeable.

OTHER SPECIES.—*Periplaneta americana* (American cockroach) is larger than *orientalis*, lighter brown in color, and has the wings well developed in both sexes. Numerous in houses about the water pipes; also abundant, often, in green-houses, feeding injuriously on various plants.

Ectobia germanica (German cockroach or Croton Bug), very common in New England cities; smaller than the two preceding roaches (about ½ in. long), very light (yellowish-brown) in color, with two longitudinal dark stripes upon the prothorax.

Blatta gigantea, found in the West Indies, attains a length of 2 inches.

CONSTITUENTS.—Fœtid oil, ammonia, trimethylamine, and a crystallizable principle, not diuretic, antihydropin.

ACTION AND USES.—Diuretic. Dose: 5 to 10 gr. (0.3 to 0.6 Gm.), in powder or tincture.

602. **HIRUDO.**—LEECH. **Sanguisu'ga medicina'lis** Savigny. Class, Vermes; order, Annelida; family, Hirudinea.

HABITAT.—Northern and Central Europe chiefly, but found more or less in all parts of Europe, in ponds of fresh water.

DESCRIPTION.—The body, which varies in length from 75 to 150 mm. (3 to 6 in.), is smooth and round, tapering toward both ends, and made up of about 100 soft rings or folds. Both ends are provided with a flattened disk, the posterior being the larger, each of which is adapted to fix upon objects by suction. The mouth has three jaws, with a double row of fine sharp teeth in each; the small anal opening is found on the under side of the last posterior wrinkle. Color of back greenish and striped longitudinally with numerous black spots; belly somewhat lighter green.

OTHER SPECIES.—Besides *S. officinalis*, which is next to *S. medicinalis* in importance and is similar in appearance (only there are no spots, and a black line extends along each side), may be mentioned *Hirudo provincialis*, *H. obscura*, and *H. interrupta*, the species common in this country being known as *H. decora*. Leeches are said to be found in great abundance throughout India.

PRESERVATION.—The usual way of keeping leeches is to place them in clear water, in a shaded spot if possible, where the temperature will range from 10° to 20° C. (50° to 68° F.), care being taken to have a considerable quantity of charcoal, moss, and pebbles in the containing vessel.

USE.—For local blood-letting, a single leech being able to extract from 1 to 2 drachms of blood.

SPECIAL ANIMAL TISSUES AND SECRETIONS.

603. **SPONGIA.**—SPONGE. **Spon'gia officina'lis** Linné. Class, Porifera; order, Ceratospongiæ.

HABITAT.—Red Sea, Mediterranean Sea, Atlantic Ocean, and other bodies of salt water, upon the rocky bottom.

COLLECTION.—The best sponges are secured by diving and cutting away their fastenings from the rocks; those of inferior quality are usually torn away with an instrument made for the purpose. The fresh sponges are exposed to the sun and washed, for the purpose of removing the animal matter with which they are filled.

DESCRIPTION.—A soft, elastic skeleton or framework of fibrous tissue surrounding the original animal matter, which, being removed, leaves a number of large and small cavities. The color is a light yellowish-brown.

VARIETIES.—The Turkey sponge is considered the best and belongs to the species *Euspongia mollisima; Euspongia zimocca*, from the coast of Greece, is harder and not so elastic. A still coarser sponge is *Euspongia equina*, collected along the north coast of Africa. The various sponges of the West Indies and Florida are different varieties of the three preceding species.

CONSTITUENTS.—A characteristic substance known as **spongin,** which yields leucin and glycocoll when treated with sulphuric acid, and when treated with KOH evolves ammonium hydrate. The ash is made up of various compounds of iodine, sodium, magnesium, calcium, etc.

USES.—Its power to absorb liquids and to expand at the same time makes sponge valuable as a surgical accessory in absorbing blood, dilating cavities, cleansing surfaces, etc., but great care should be exercised in its use, so that the same sponge may not be used more than once without being thoroughly washed in a dilute solution of carbolic acid; otherwise there is danger of contamination by infection, which is easily carried from one patient to another when the same sponge is used repeatedly. Burnt

sponge is occasionally administered, on account of the iodides of sodium and potassium which it contains, in cases of goiter and scrofulous swellings.

604. **CORALLIUM.**—CORAL. **Oculi'na virgi'nea** Lamarck. Class, Polypifera; order, Hexacoralla.

HABITAT.—Atlantic Ocean and Mediterranean Sea.

DESCRIPTION.—A hard, calcareous substance produced by coral polypi. The pieces are often branched, presenting a surface more or less porous and striate, and the interior is radiate or hollow.

VARIETIES.—Besides *Oculina virginea* there are several other species, among which may be mentioned *Corallium rubrum*, the red coral.

CONSTITUENTS.—Calcium carbonate 83 per cent., animal matter 7 to 8 per cent., magnesium carbonate 3 to 4 per cent., and ferric oxide 4.25 per cent. (in the red coral).

USES.—Antacid. Used in tooth powders. Dose: 5 to 15 gr. (0.3 to 1 Gm.).

605. **TESTA.**—OYSTER SHELL.

SOURCE.—*O'strea virginia'na* and *O. edulis*, which excrete a calcareous bivalved covering or shell, and inhabit the shallow coast water of the Atlantic and Indian Oceans.

DESCRIPTION.—External surface rough, inner surface smooth and white, the two toothless, hinged valves made up of imbricate, foliaceous layers, presenting, when closed, an irregularly rounded, oblong, or ovate form.

CONSTITUENTS.—Largely calcium carbonate, there being only 4 per cent. or less of animal matter present and a small percentage of silica, alumina, magnesia, and calcium phosphate and sulphate.

USES.—Antacid. The shell, to be used, should first be thoroughly purified and washed in boiling water. Dose: 5 to 15 gr. (0.3 to 1 Gm.).

606. **OS SEPIÆ.**—CUTTLEFISH BONE.

SOURCE.—*Se'pia officina'lis* is the species from which this calcareous bone is obtained; it inhabits the Atlantic Ocean and the Mediterranean Sea.

DESCRIPTION.—A white, flattish, oval-oblong bone about 100 mm. (4 in.) in length; exterior hard and smooth, interior porous and friable; inodorous; taste somewhat saline and earthy.

CONSTITUENTS.—Mostly calcium carbonate, with from 10 to 15 per cent. of animal matter and a very small percentage of sodium chloride, calcium phosphate, and magnesia.

USES.—An antacid. Extensively employed in the manufacture of tooth powders, and used to some extent as a polishing agent.

607. **CALCULI CANCRORUM.**—CRABS' STONES.

SOURCE.—The stomach of the crab (*Asta'cus fluviati'lis* Fab. or *Cancer astacus* Linné), where they are formed by concretions. The crab is found in rivers throughout the North Temperate Zone.

DESCRIPTION.—The circular, plano-convex stones vary in size from 3 to 10 mm. ($\frac{1}{8}$ to $\frac{2}{5}$ in.) in diameter, and are white and hard, changing in hot water to a rose-red; tasteless and inodorous. When treated with hydrochloric acid, they effervesce until nothing is left but a small plano-convex, cartilaginous mass.

SUBSTITUTIONS.—Artificial stones are sometimes manufactured, but can be distinguished from the true crabs' stones by treating with HCl, when, if they are artificial, they leave little or no residue.

CONSTITUENTS.—Calcium carbonate 63 per cent., calcium phosphate 17 per cent., animal matter 12 to 15 per cent., and small portions of phosphate of magnesium and sodium salts.

USES.—Antacid.

608. **ICHTHYOCOLLA.**—ISINGLASS. Off. in U. S. P. 1890. The swimming-bladder or sound of the Sturgeon, a fish found in the Black and Caspian Seas and their tributary streams. The swimming-bladders of other fish are also employed for this purpose, but the isinglass from the

Russian species, *Acipenser huso*, *A. guldenstadtii*, *A. ruthenus*, and *A stellatus*, is considered the finest and purest. The inner layer of the swimming-bladder is separated from the outer, and after being washed is thoroughly dried. The sheets of commercial isinglass are prepared in various forms,—leaf isinglass (single sheets), book isinglass (several sheets folded together), and staple isinglass. In appearance it resembles horn, is of a yellowish-white color, semitransparent and iridescent. The substance is tough, tearing with difficulty even in the direction of the fibers, but dissolves completely in hot water, forming a transparent jelly on cooling in a solution of 24 parts of the same. *Constituents:* Gelatin (98 per cent., in the best Russian variety) and from 2 to 30 per cent. of insoluble membrane, the ash amounting to only about 0.5 per cent. Nutritive, easily digested. Emollient and protective externally.

609. **AMBRA GRISEA.**—AMBERGRIS.

SOURCE.—*Physe'ter macroceph'alus*, a species of whale inhabiting the Indian Ocean and the southern part of the Pacific Ocean, excretes a substance from the intestines which is found floating on the surface of the water; this is known as ambergris.

DESCRIPTION.—Waxy, grayish-brown, with streaks and dots; odor peculiar, taste slight; soluble in hot alcohol, ether, fats, and volatile oils.

CONSTITUENTS.—Ambrein (brilliant white needles precipitated from alcoholic solution) 85 per cent., a balsamic extractive, and a very small proportion of ash. On account of its high price adulterations of and substitutions for ambergris are common, but the genuine article is easily distinguished by means of its complete solubility in hot alcohol, and evaporation without evolving acrid vapor.

Preparation of Ambrien.—Obtained by crystallizing from hot alcoholic solution of ambergris; it forms white, shining, tasteless, and inodorous needles which fuse near 350° C.

USES.—As a perfume it is highly prized. It possesses very uncertain medical properties and is very rarely administered as a remedial agent.

610. **OLEUM MORRHUÆ.**—COD-LIVER OIL. A fixed oil obtained from the fresh livers of **Ga'dus mor'rhua** Linné, or of other species of Gadus (class, Pisces; order, Teleostei; family, Gadidæ). For tests see U. S. P. *Description:* A pale yellow thin oily liquid. Peculiar, rancid odor; bland, fishy taste. Specific gravity at 15° C. (59° F.) 0.922 to 0.927. Should be kept in dry, well stoppered bottles. *Constituents:* Chiefly olein, palmitin, and stearin. The oil also contains dissolved in it minute quantities of the halogen elements, iodine, bromine, and chlorine, with phosphorus and sulphur. A peculiar substance named gaduin is also claimed to have been found. A crystalline substance, morrhuol, a compound body containing phosphorus, iodine, and bromine, is also said to be among the "active principles" of cod-liver oil. *Action and Uses:* A nutritive agent, generally of easy assimilation. It has long been used as a stimulant and alterative in rheumatic and strumous diseases. In pulmonary consumption it has for a long time enjoyed a great reputation. Dose: a tablespoonful (½ fl. oz.) three or four times a day.

611. CETACEUM.—SPERMACETI.

SPERMACETI. *Ger.* SPERMACETIS.

A peculiar concrete, fatty substance obtained from the head of the sperm whale, **Physe'ter macroceph'alus** Linné (class, Mammalia; order, Cetacea).

DESCRIPTION.—A pearly-white, somewhat translucent, waxy mass, but of a somewhat granular texture, fusing at about 45° C. (113° F.). Odor faint and bland, taste mild. Insoluble in water, soluble in 50 parts

of boiling alcohol; also in ether, chloroform, and carbon-disulphide. It becomes yellow and rancid on exposure to air.

CONSTITUENTS.—Mainly cetin (cetyl palmitate, $C_{16}H_{33}$, $C_{16}H_{31}O_2$), with small amounts of other fatty compounds.

USES.—Mainly as a base for cerates and ointments.

612. MEL.—HONEY.

HONEY. *Ger.* HONIG.

A saccharine secretion deposited in the honeycomb by the bee, **A'pis mellif'era** Linné (class, Insecta; order, Hymenoptera).

DESCRIPTION.—For description and Tests see U. S. P.

USES.—Mainly as a vehicle for remedial agents.

The honeycomb, from which the honey is drained, is the source of the two official products:

612 **a. CERA FLAVA.**—YELLOW WAX. BEESWAX. Obtained by slicing the honeycomb, draining it thoroughly, melting the residue after impurities have subsided, and allowing the melted liquid to cool. A yellowish or brownish-yellow solid, having an odor suggesting honey, and a rather agreeable taste. It melts at about 63° C. (145.4° F.). For Tests see U. S. P.

612 **b. CERA ALBA.**—WHITE WAX. BLEACHED WAX. The yellow wax is bleached by exposing an extended surface to the light and atmospheric influence. This is done in various ways. Bleaching may be accomplished by chemical means, such as by the use of chlorine gas, etc. A white, shining, inodorous, insipid solid, fusing at about 65° C. (149° F.). For Tests see U. S. P.

USES.—As an ingredient in cerates, ointments, plasters, etc.

613. **OVUM.**—EGG.

SOURCE.—The egg of the common domesticated hen (probably from India originally) is well known as an article of food throughout the country.

DESCRIPTION.—A thin, calcareous shell incloses an albuminous substance known as white of egg, which in turn incloses the vitellus or yolk.

CONSTITUENTS.—The three parts of an egg are entirely separate and distinctive in composition.

(*a*) *Testa Ovi*, Egg-shell.—Almost pure calcium carbonate (90 to 97 per cent.), the remainder being made up of magnesium and calcium phosphates, together with about equal quantities of organic matter.

(*b*) *Albumen Ovi*, White of Egg.—Made up mostly of a solution of albumen and water (albumen 15 per cent., water about 85 per cent.), with slight traces of fat and sugar, as well as KCl and NaCl, which are the chief components of the ash.

(*c*) *Vitellus*, U. S. P. 1890.—Egg Yolk, or Yelk. Compounded of water (about 52 per cent.), fat (30 per cent.), vitellin (16 per cent.), and inorganic salts (1.5 per cent.), such as chloride of sodium, sulphates and phosphates of magnesium, etc., together with coloring matter and traces of lactic acid and sugar.

ACTION AND USES.—Shell sometimes used as antacid. The white, besides its nutriment, is valuable as an antidote when corrosive sublimate,

sulphate of copper, or other metallic poisons have been taken into the stomach. The yolk is even more nutritious than the white, having a greater amount of digestible solids. It is used in preparing emulsions of oils and applied as a dressing for burns.

614. MOSCHUS.—Musk.

MUSK. *Ger.* MOSCHUS.

The dried secretion from the preputial follicles of **Mos′chus moschif′erus** Linné (Fam. Ruminantia).

Source.—Musk is obtained from a small bag or sac attached to the prepuce of the male Musk deer, *Mos′chus moschif′erus*, a species of hornless deer found in Central Asia from Thibet to China. The musk-sac is somewhat oval and about 50 mm. (2 in.) in diameter, containing in the mucous lining a number of delicate glands which secrete the musk.

Description.—A granular substance of a brownish or reddish-black color, having a very strong, peculiar, and penetrating odor. The granules are irregular in size, and have a smooth, oily appearance and a bitter taste. The color of the fresh article is considerably lighter than that which has been dried and prepared for the market, although the commercial product is estimated to contain about 10 per cent. of moisture. The dried musk is contained in the original sac, one-half of which is smooth and the other covered with hairs arranged concentrically around two orifices. The quantity of musk in each sac amounts to about 160 grains. Not more than one-tenth of this musk is dissolved by strong alcohol, with which it forms a light yellowish-brown tincture, while as much as one-half of it can be dissolved in water, forming with it a dark brown solution having a very strong odor. Should not contain more than 15 per cent. of moisture nor 8 per cent. of ash.

Fig. 262.—Tonquin Musk. Pod. (⅔ natural size.) (Photograph.)

Varieties.—Besides the Chinese or Thibetan musk, which is of the most excellent quality, there is also a Siberian musk, the quality of which is inferior. There is also an artificial musk which comes more properly under the head of adulterations. The Siberian or Russian variety is generally quite easily distinguished, the containing sac being more elongated than that of the Chinese variety, and the hair thinner and lighter.

ADULTERATIONS.—An artificial musk is manufactured by the Chinese and is made up chiefly of a mixture of blood and ammonia to which a small quantity of real musk is added, the whole being inclosed in a piece of the skin of the musk ox. Resin, lead, and other substances are also resorted to in preparing adulterations.

CONSTITUENTS.—Free ammonia, fat, albumen, an acid, wax, and gelatinous principles can be easily separated, but it has been impossible to separate the odoriferous principle. The gray ash left after burning the pure musk constitutes about 8 per cent. of the drug. The odor of musk is destroyed or greatly modified by the action of several substances, such as camphor, ergot, hydrocyanic acid, etc.

ACTION AND USES.—Antispasmodic and diffusible stimulant, together with more or less aphrodisiac action. Its powerful and lasting odor makes it valuable as a perfume, either alone or in combination with other substances. Dose: 1 to 10 gr. (0.065 to 0.6 Gm.), administered in the form of powder, pills, or enema, the powder being generally taken with milk.

OFFICIAL PREPARATION.

Tinctura Moschi (5 per cent.), ...Dose: 2 fl. dr. (8 Cc.).

615. FEL BOVIS.—Ox Gall.

OX GALL. *Ger.* OCHSEN GALLE.

The fresh bile of **Bos taurus** Linné (Fam. Ruminantia).

DESCRIPTION.—The fresh bile of the ox is a brownish or dark green, viscid liquid, with a characteristic, unpleasant odor, and a nauseous, bitter taste. It is neutral or faintly alkaline. Pettenkofer's test for this liquid is as follows: Two drops in 10 Cc. of water, when treated, first with a drop of freshly prepared solution of one part of sugar and four parts of water, and afterward with sulphuric acid cautiously added until the precipitate first formed is redissolved, gradually acquires a brownish-red color, changing successively to carmine, purple, and violet.

OFFICIAL PREPARATION.—**Fel Bovis Purificatum.** The method by which this medicinal preparation of the crude ox-gall is made, according to the U. S. Pharmacopœia, is as follows: Fresh ox-gall 300 Cc.; alcohol 100 Cc. Evaporate ox-gall in tared porcelain capsule on water-bath to 100 Gm.; add to it the alcohol. When precipitation has occurred and the solution cleared, the clear liquid is decanted, the remainder filtered, and the filtrate evaporated to a pilular consistence.

Purified ox-gall is a yellowish-green, soft solid, having a peculiar odor and a sweetish, bitter taste.

ACTION AND USES.—The purified ox-gall only is used in medicine. It is tonic and laxative, at one time much used to increase the secretion of bile. Dose: 3 to 10 gr. (0.2 to 0.6 Gm.).

616. **SANGUIS.**—BLOOD.

SOURCE.—The ox (*Bos taurus* Linné) furnishes this liquid from the arterial circulation of the vascular system.

DESCRIPTION.—A red, opaque fluid, slightly heavier than water (sp. gr. 1.05), containing corpuscles in suspension, and coagulating on exposure.

CONSTITUENTS.—Chiefly water (78 per cent.), with albumen 7 per cent., salts 9 per cent., fibrin 4 per cent., and corpuscles and other constituents 13 per cent. Hæmoglobin is a peculiar coloring matter made up of globulin and hæmatin, which gives blood its red appearance.

MEDICAL PROPERTIES.—Desiccated blood has enjoyed some reputation as a nutritive or restorative, the dose being about 15 gr. (1 Gm.), but it has not been very generally adopted as an agent among therapeutists for treatment of debilitated conditions.

617. **LAC.**—MILK.

SOURCE.—The mammary glands of the cow (*Bos taurus*), the well-known domestic animal.

DESCRIPTION.—A white, opaque liquid or emulsion, made up of butter and casein, and having a pleasant taste and slight odor; specific gravity about 1.030. When allowed to stand for a few hours, the oily globules rise to the surface on account of their lower specific gravity. Under the microscope these globules are seen to be separate, and each surrounded by an albuminous envelope, but when a caustic alkali is added, this envelope is destroyed, so that the globules are released and accumulate as pure butter. When exposed for a considerable time in a warm place, milk changes from sweet to sour on account of the development of an acid by chemical action between the constituents.

CONSTITUENTS.—A large percentage (about 87 per cent.) of milk is represented by water, 4 per cent. by butter, 5 per cent. by sugar and soluble salts, and only about 3.6 per cent. by casein and insoluble salts.

Butter is composed of olein (about 30 per cent.), palmitin, and stearin (68 per cent.), and about 2 per cent. of glycerides of butyric and other acids.

Casein, which is soluble in a solution of the alkalies, is a modification of albumen, and is precipitated from solution by the action of rennet or acetic acid.

Lactic acid (Acidum Lacticum, U. S.), which is developed by the action of heat, is said not to be a normal constituent of milk, but is always present in sour milk. Syrupus Calcii Lactophosphatis employs this acid. Dose: 8 Cc. (2 fl. dr.).

617 **d. SACCHARUM LACTIS,** U. S.—SUGAR OF MILK. LACTOSE. Forms about 5 per cent. of milk and is obtained from the whey by evaporation and recrystallization. A hard, somewhat gritty, slightly sweet powder, almost inodorous. Soluble in about six parts of water. For Tests see U. S. P. It has been recommended as a dietetic in wasting diseases, but in pharmacy is merely a diluent for triturations of various kinds.

ACTION AND USES.—Milk is nutritious, and its value as an article of diet is well known. In addition to this use, milk may be satisfactorily employed as a vehicle for the administration of certain remedies having an unpleasant taste.

618. **OS.**—BONE.

SOURCE.—The skeleton of vertebrate animals.

CONSTITUENTS.—Calcium phosphate 40 to 67 per cent., which includes a small percentage of calcium carbonate; phosphates of magnesium and other salts are also present. With the salts are also found organic substances yielding gelatine on boiling with water. The basic substance of the

bony structure contains two chief constituents, namely, an organic substance, *ossein*, and the so-called bone earth inclosed in or combined with it. Ossein is generally considered identical with collagin of the connective tissue.

Preparation of Ossein: that portion of bone that is left undissolved after treatment with HCl.

USES.—For preparing bone-black, animal charcoal, and phosphates.

619. **GELATINUM** (U. S.).—GELATIN.

SOURCE.—Bone, cartilage, skin, tendons, and ligaments; a boiling-hot solution of these, resulting in a jelly when cooled, is dried in the air.

DESCRIPTION.—Thin, transparent sheets or porous, opaque layers or shreds, amorphous, swelling in water without dissolving, dissolving in warm water, forming a sticky liquid which solidifies on cooling. The solution is lævogyrate. Solutions of gelatin on boiling are not precipitated either by mineral acids, acetic acid, alum, lead acetate, or mineral salts in general, but precipitated by potassium ferrocyanide, tannic acid, mercuric chloride in the presence of HCl and NaCl, and by alcohol, especially when neutral salts are present. Its solution containing KCr_2O_7 yields an insoluble compound on exposure to light.

Gelatinoids.—To this group belong a number of substances occurring in bones, skins, horns, etc., having generally the property of forming a jelly with water. The organic matter in bones, usually called ossein, contains, besides albuminous substances, the two gelatinoids, collagin and gelatin, a pure mixture of which forms common glue. Chondrin resembles gelatin; it is obtained from cartilages of the ribs and non-ossifying cartilages; its aqueous solution is precipitated by alum, lead acetate, ferric salts, acetic acid, and a small quantity of mineral acid, but not precipitated by tannin or mercuric chloride. Properties: Emollient, nutritive, and protective.

620. SEVUM.—SUET.

MUTTON SUET. *Ger.* HAMMELSTALG.

The internal fat of the abdomen of **O'vis a'ries** (class, Mammalia; order, Ruminantia), purified by melting and straining. Suet should be kept in well-closed vessels impervious to fat. It should not be used after it has become rancid.

DESCRIPTION.—White, unctuous, smooth solid, melting at about 48° C. (113° F.). Sevum Præparatum (U. S.) is identical with suet as above described.

CONSTITUENTS.—Stearin, palmitin, and olein, with a preponderance of the first mentioned.

USES.—Lenitive, as an external application and as a base for unctuous preparations.

621. **OLEUM BUBULUM.**—NEAT'S-FOOT OIL. From the fatty tissue of the feet of the ox, previously deprived of hoofs, obtained by boiling in water and skimming off the fat, which is subsequently strained and pressed. At ordinary temperatures this is a semifluid, oleaginous fat, of a peculiar odor.

CONSTITUENTS.—Mainly olein, with solid fats. Used externally.

622.—ADEPS.—Lard.

LARD. *Ger.* SCHWEINESCHMALZ.

The prepared internal fat of the abdomen of **Sus scrof'a** Linné (class, Mammalia; order, Pachydermata), purified by washing with water, melting, and straining. Lard should be kept in well-closed vessels impervious to fat, and in a cool place. For Tests see U. S. P. (Var. domestica)

Description.—A white unctuous solid with faint odor and bland taste. Insoluble in water. Soluble in chloroform, carbon bisulphide and benzine. Specific gravity at 15° C. (59° F.) about 0.932.

Constituents.—Olein, stearin, and palmitin; of the first mentioned it consists of about 50 to 60 per cent.

Uses.—Emollient, and as a base for ointments and cerates.

622 a. **OLEUM ADIPIS,** U. S.—Lard Oil. A pale yellowish or colorless fixed oil having a slight odor and taste. It is produced by exposing lard, at a low temperature, to strong pressure.

Constituents.—Olein, with palmitin and stearin. Used externally.

623. PEPSINUM.—Pepsin.

PEPSIN. *Ger.* PEPSIN.

A proteolytic ferment or enzyme obtained from the glandular layer of fresh stomachs of healthy pigs, and capable of digesting not less than 3000 times its own weight of freshly coagulated and disintegrated egg albumen when tested by U. S. P. process.

Source.—Pepsin is prepared from the stomach of the ox (*Bos taurus*), the sheep (*Ovis aries*), or the hog (*Sus scrofa*), the mucous membrane being the part used. Several methods have been employed for its extraction. The ordinary methods of manufacture may be briefly stated as follows:

(1) The extraneous matter is first removed from the inner surface of the stomach by washing, and the mucous membrane scraped off with a blunt instrument; the pulp thus obtained is placed on glass or porcelain and dried and finally reduced to a powder. This forms a rather poor quality, owing to the presence of mucus and inert matter.

(2) The finely chopped mucous coat is macerated in dilute hydrochloric acid (about 2 per cent.), and to the filtered solution common salt is added; the floating precipitate which results is carefully washed, then dried, and the dried residue mixed with sugar of milk until the strength of the article is such that 1 grain will dissolve 3000 grains of coagulated albumen, the strength directed by the United States Pharmacopœia.

(3) A scale pepsin is made by digesting the mucous lining at the

temperature of about 100° C. with about 0.2 per cent. of HCl (or water acidulated with other acids to the same degree of acidity) until the membrane is completely or nearly all dissolved. The solution is neutralized by a suitable alkali and the filtered product, after reduction by evaporation at a low temperature (sometimes in vacuo) to a syrupy consistence, is spread on plates of glass and dried in a current of warm air, care being taken not to allow the temperature to exceed 40° C. (104° F.). The dried, transparent film is then scraped from the plates and broken into more or less fine lamellæ.

Description.—A yellowish-white amorphous powder or thin, pale yellowish, somewhat transparent scales, with faint odor and slight saline or acidulous taste, but no indication of decomposition; should not be hygroscopic. In the form of saccharated pepsin it is insoluble in alcohol, but soluble in water, and has a curdling action on milk. Heat destroys its proteolytic power.

Tests.—The U. S. P. method and many others are based on the property of pepsin to dissolve (digest) coagulated albumin. Allen's method (seemingly a more accurate one) analyzes the products of digestion. See "Commercial Organic Analysis," Allen, volume IV, second edition, page 350.

Action and Uses.—Pepsin has a digestive action upon the food taken into the stomach, and is employed as an artificial agent to assist digestion when there is functional derangement of the stomach. Dose: 10 gr. (0.6 Gm.).

Pepsinum Saccharatum (Pepsin 10 Gm., sugar of milk 90 Gm., U. S., 1890), ... Dose: 8 to 15 gr. (0.5 to 1 Gm.).

624. PANCREATINUM.—Pancreatin.

A mixture of enzymes (Amylopsin, Myopsin, Trypsin, Steapsin) existing in the pancreas of warm-blooded animals capable of converting at least twenty-five times its weight of starch into substances soluble in water.

Source.—Prepared from the pancreas of the hog, by mixing finely chopped pancreas with half its weight of cold water and straining the liquid by pressure through cheese-cloth or flannel. To the filtrate alcohol is added (about one volume), and the resulting precipitate collected and dried. (For details see National Formulary.)

Description.—Yellowish-white amorphous powder with but slight odor and meat-like taste; slowly soluble in water, insoluble in alcohol.

Test.—If there be added to 4 fl. oz. of tepid water contained in a suitable flask or bottle, first 5 gr. of pancreatin, 20 gr. of bicarbonate of sodium, and afterward one pint of fresh cow's milk previously

heated to 38° C. (100.4° F.), and if this mixture be maintained at the same temperature for thirty minutes, the milk should be so completely peptonized that, upon adding to a small portion of it transferred to a test-tube a slight excess of nitric acid, coagulation should not occur. For Assay see U. S. P., page 331.

ACTION AND USES.—Used as a digestive agent. Dose: 10 gr. (0.6 Gm.).

625. ADEPS LANÆ HYDROSUS.—LANOLIN.

HYDROUS WOOL-FAT.

The purified fat of the wool of sheep, **Ovis aries** Linné (class Mammalia; order, Ruminantia), mixed with not more than 30 per cent. of water. For Tests see U. S. P.

DESCRIPTION.—A yellowish-white unctuous mass. Faint, peculiar odor. Insoluble in water, but miscible with twice its weight. Melts at about 40° C. (104° F.). **Adeps Lanæ,** U. S., is the above freed from water.

CONSTITUENTS.—Cholesterin, palmitin, olein, the first mentioned being largely represented.

USES.—As an inunction and vehicle for substances the medicinal action of which can be obtained by local application. It is employed in several official ointments. The anhydrous used in Goulard's cerate.

625 a. **HYDROCARBON FATS AND OILS.**

DESCRIPTION, SOURCE, ETC.—As a most valuable addition to the list of ointment bases and oleaginous liquids there has been officially recognized: Petrolatum album (White Petrolatum); Petrolatum Liquidum (oil); Petrolatum Molle (soft Petrolatum); and Petrolatum Spissum (Hard Petrolatum). These are mixtures of the harder and softer members of the paraffin series of hydrocarbons, having different melting and congealing points, etc. Hard paraffin consists chiefly of hydrocarbons ranging from $C_{20}H_{42}$ to $C_{30}H_{62}$; soft paraffin consists chiefly of $C_{15}H_{32}$ to $C_{20}H_{42}$; liquid consists chiefly of heptane, C_7H_{16}, and octane, C_8H_{18}.

USE.—As a vehicle for medicinal substances applied locally. As such it is much less permeable through the skin than other fats.

626. **HYRACEUM.**—A plaster mass of a blackish-brown color, occasionally used medicinally as a stimulant and antispasmodic. When warmed, it emits the odor of castor. It is an animal excretion found in Africa.

627. **CASTOREUM.**—CASTOR.

SOURCE.—The preputial follicles of both sexes of *Cas'tor fi'ber* Linné These follicles are not perceptible until the outer skin is removed, when they are seen to lie between the cloaca and pubic arch of the animal. This species of animals is commonly known as the beaver, and is found more or less throughout the Temperate and North Temperate Zones.

DESCRIPTION.—The dry, resinous, brownish contents of the fig-shaped sacs or follicles have a strong and peculiar odor, an acrid, nauseous taste, and are soluble in alcohol and ether. An aqueous decoction of castor is of a light yellowish-brown color which becomes turbid on cooling, and changes to a dark color when ferric chloride is added.

VARIETIES.—American or Canadian, and Russian or Siberian Castor. The Russian variety differs from the American in the size of the inclosing follicles; in the former the size varies from 2½ oz. to 8 oz. (75 to 240 Gm.) in weight, and in the latter from 1 to 4 oz. (30 to 120 Gm.). There is also a

difference in the composition of the product from the different varieties, the American probably containing a larger percentage of resin.

ADULTERATIONS.—Earthy matters, as well as resin and blood, are sometimes used for this purpose, but not frequently. The product from diseased animals is also met with; this often contains as much as 50 per cent. of inert material and is of a brownish-gray color.

CONSTITUENTS.—A bitter resinous substance 14 to 58 per cent., 1 to 2 per cent. of volatile oil containing carbolic acid, a small quantity of castorin (a colorless, odorless and tasteless, crystalline, non-saponifiable fat, soluble in ether and boiling alcohol), together with salicin, cholesterin, and about 3.5 per cent. ash. The resin is dark brown, slightly acid, soluble in alcohol but not in ether. The volatile oil contains the odoriferous principle and is generally colorless, having an acrid, bitter taste.

ACTION AND USES.—Castor enjoys some reputation as a stimulant, antispasmodic, and emmenagogue, and is employed in cases of hysteria, chorea, and epilepsy, associated with sexual disorders. On account of its disagreeable taste it is best administered in the form of a pill.

DOSE.—5 to 10 gr. (0.3 to 0.6 Gm.) in the form of a pill; 1 to 4 fl. dr (4 to 15 Cc.) of the tincture.

628. **CIVETTA.**—CIVET.

SOURCE.—The glandular pouch between the genitals and anus of the male and female animals belonging to the two species **Viver'ra zibe'tha** Schreber, and **V. civetta** Schreber, the first of which is found in Southern Asia and the other in Africa.

DESCRIPTION.—The secretion, when fresh, is yellowish, becoming brown with age, soluble in hot absolute alcohol, partly soluble in ether, and insoluble in water; odor musk-like; taste acrid and nauseous.

ADULTERATIONS.—Butter or lard is not infrequently used as an adulterant of the commercial article.

CONSTITUENTS.—Resinous and coloring matters are the chief components, together with volatile oil and fat.

ACTION AND USES.—The manufacture of perfumery is the principal use of civet, but it is also sometimes administered as a stimulant and antispasmodic in doses of 5 to 15 gr. (0.3 to 1 Gm.). As a perfume it is superior to musk, as the odors of various kinds of flowers can be successfully imitated with it.

BACTERIAL PRODUCTS.

629. ANTITOXIC SERUMS.

In recent years there has grown up almost a new system of therapeutics, known as "serum therapy." This system is based upon the theory that the various infectious diseases are in most instances caused by the poisonous toxins produced by the micro-organisms. As an example of the diseases thus produced, diphtheria is perhaps the most striking, because it is the most common, and the success in its treatment by this system has been universally acknowledged as phenomenal. In addition to diphtheria, we have tetanus, septicemia, glanders, cholera, etc. These diseases are now treated by hypodermic injection of the well-known animal serums containing different percentages of

antitoxins. These antitoxic serums are practically produced *in the animal*—the goat, cow, or horse, for instance. The animal is gradually rendered immune to the specific micro-organisms by the injection of either attenuated cultures rendered comparatively harmless by heat and cultivation at relatively high temperature, or very minute quantities of the virulent organism itself.

After the animal has been rendered immune by this treatment, blood is withdrawn from it with the strictest aseptic precautions; it is then allowed to stand until the blood serum separates as a distinct layer. This blood serum, when separated and hermetically sealed in glass bulbs, etc. (containing 5 Cc. and upwards), constitutes the remedial agent. It is needless to state that from the beginning until the very end of the process the greatest aseptic precautions are observed. The liquid before being placed in its containers is impregnated with minute quantities of such preservative material as tricresol, carbolic acid, etc. As these serums are tested only in the physiological laboratory, the pharmacist must of necessity hold the manufacturer responsible for the value of his product.

629 **a. SERUM ANTIDIPHTHERICUM.**—Diphtheria Antitoxin.
Dose.—Depends on age and condition of patient. Average dose 3000 units. Immunizing dose for well persons 500 units.

GLANDULAR PRODUCTS.

630. GLANDULÆ SUPRARENALES SICCÆ.

From the suprarenal gland is prepared a principle known as "Adrenalin," which, according to von Fürth, is identical with Suprarenin. Abel has isolated Epinephrin as the active constituent contained in the medulla of the gland. The physiological activity of these principles is very great: in the minute quantity of 0.000001 gm. per kilogram of body-weight it is still able to raise the blood-pressure distinctly.

It is one of the most powerful hemostatics known (a fraction of one drop of aqueous solution of adrenalin or its salt—Adrenalin Chloride—in strength of 1 : 50,000 blanches the normal conjunctiva within one minute).

Action and Use.—The action of the remedy is very short, but the prin-

ciple is very resistant against acids and heat. It is soluble in water. Employed as a local application to stop hemorrhage, especially in

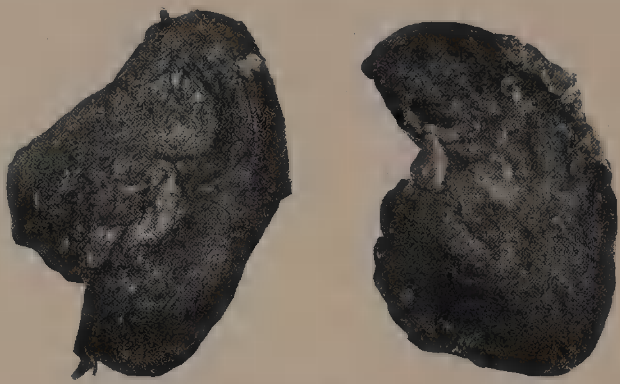


FIG. 263.—Suprarenal Capsules. (2/3 natural size.) (Photograph.)

nasal and laryngeal operations. Ophthalmologists find results most valuable from it when applied to the eye to relieve congestion. See article by Dr. Takamine, "Am. Jour. Pharm.," 1901, p. 523.

631. GLANDULÆ THYROIDEÆ.

Thyroid glands differ from the suprarenal glands in that they exert their action when taken by the mouth. Bauman has isolated a substance very rich in iodine from the fluid (9.3 per cent.) which he calls "iodothyrin." It also contains nitrogen and phosphorus.

GLANDULÆ THYROIDEÆ SICCÆ (DESICCATED GLANDS).

There are prepared from the fresh and healthy thyroid gland of the sheep by removing the external fat, connective tissue, and abnormal parts from the thyroid glands taken from the sheep immediately after killing; mincing finely; drying at 90° to 100° F.; powdering the dried product; removing all fat from it by washing with petroleum spirit; and again drying the residue.

LIQUOR THYREOIDEI.—THYROID SOLUTION.

This is prepared as above from the healthy thyroid gland of the sheep, bruising thoroughly; adding for each entire gland (consisting of two lobes) 34 minims of glycerin and 34 minims of a 0.5 per cent. solution of phenol in distilled water; transferring the mixture, well stirred, to a flask, closed with cotton-wool; allowing it to stand for twenty-four hours; straining through linen; and adding to the

strained liquid sufficient of the 0.5 per cent. solution of phenol to make 100 minims of the liquor for each gland used.

ACTION AND USE.—Thyroid extract, when taken internally, affects metabolism; the body-weight falls at first, but rises afterward as health is restored. Nutrition is roused to fresh activity. Used in myxœdema and sporadic cretinism, two diseases that are associated with disease or defect of the thyroid gland. Dose of dry thyroid, or iodothyrin, 3 to 10 gr. (0.2 to 0.6 Cc.); of the solution, 5 to 15 ♏ (0.3 to 1 Cc.).

SECTION III.—(A.) SYNOPSIS OF NATURAL ORDERS, OR FAMILIES, AND OF DRUGS, ARRANGED ACCORDING TO PART II.*

(*Number refers to number of drug—not to page. Dagger* (†) *refers to changes in families,* *see p.* 496.)

Ranunculaceæ.

CIMICIFUGA, 1.
HYDRASTIS, 2.
Actæa, 3.
Coptis, 4.
Helleborus Niger, 5.
Helleborus Viridis, 6.
Xanthorrhiza, 7.
Pulsatilla, 8.
Adonis Vernalis, 9.
Ranunculus, 10.
STAPHISAGRIA, 11.
Delphinium, 12.
Nigella, 13.
ACONITUM, 14.
Hepatica, 15.
Pæonia, 16.

Calycanthaceæ.

Calycanthus, 17.

Magnoliaceæ.

Illicium, 18.
Magnolia, 19.
Wintera, 20.
Liriodendron, 21.

Menispermaceæ.

CALUMBA, 22.
PAREIRA, 23.
Menispermum, 24.
Cocculus, 25.

Berberideæ.

CAULOPHYLLUM, 26.
PODOPHYLLUM, 27.
Jeffersonia, 28.
Berberis Radix, 29.
Berberis Cortex, 30.
BERBERIS, 31.

Nymphæœ.

Nymphæa, 32.

Sarraceniaceæ.

Sarracenia, 33.

Papaveraceæ

OPIUM, 34.
Papaver, 35.
Papaveris Semen, 36.
Chelidonium, 37.
Eschscholtzia, 38.
SANGUINARIA, 39.
Rhœas, 40.

Fumariaceæ.

Corydalis, 41.

Cruciferæ.

SINAPIS ALBA, 42.
SINAPIS NIGRA, 43.
OLEUM SINAPIS VOLATILE, 43.
Oleum Sinapis Expressum, 43 a.
Bursa Pastoris, 44.
Armoracia, 45.

Cistineæ.

Helianthemum, 46.

Violarieæ.

Viola Tricolor, 47.

Canellaceæ.

Canella, 48.
Cinnamodendron, 49.

Bixineæ.

Gynocardia, 50.
Oleum Gynocardiæ, 50 a.
Annatto, 51.

Polygaleæ.

†**KRAMERIA,** 52.
SENEGA, 53.
Polygala, 54.

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* Natural orders in Italics and official drugs in bold-face type.

Frankeniaceæ.

Frankenia, 55.

Caryophyllaceæ.

Saponaria Levantica, 56.
Saponaria, 57.
Stellaria, 58.

Portulaceæ.

Portulaca, 59.

Hypericineæ.

Hypericum, 60.

Guttiferæ.

CAMBOGIA, 61.
Mangostana, 62.

Ternstrœmiaceæ.

Thea, 63.

Dipterocarpeæ.

Gurjun, 64.
Borneo Camphor, 65.

Malvaceæ.

ALTHÆA, 66.
Althæa Rosea, 67.
Malva, 68.
Cotton Derivatives, 69.
GOSSYPII CORTEX, 69 a.
GOSSYPIUM PURIFICATUM, 69 b.
OLEUM GOSSYPII SEMINIS, 69 c.

Sterculiaceæ.

Cola, 70.
Theobroma, 71.
OLEUM THEOBROMATIS, 71 a.

Tiliaceæ.

Tilia, 72.

Linaceæ.

LINUM, 73.
OLEUM LINI, 73 a.
†**COCA**, 74.

Zygophyllaceæ.

Guaiaci Lignum, 75.
GUAIACUM, 76.

Geraniaceæ.

GERANIUM, 77.
Impatiens, 78.

Rutaceæ.

Angustura, 81.
Ptelia, 82.
XANTHOXYLUM, 79.
Xanthoxyli Fructus, 80.
BUCHU, 83.
PILOCARPUS, 84.
Ruta, 85.
Bela, 86.
AURANTII CORTEX, 87.
OLEUM AURANTII CORTICIS, 88.
Aurantii Folia, 89.
Aurantii Flores, 90.
LIMONIS SUCCUS, 91.
LIMONIS CORTEX, 92.
OLEUM LIMONIS, 93.
Oleum Bergamottæ, 94.
White Zapote, 95.

Simarubaceæ.

QUASSIA, 96.
Quassiæ Cortex, 97.
Simaruba, 98.
Cedron, 99.
Ailanthus, 100.
Cascara Amarga, 101.
Chaparro Amargoso, 101½.

Burseraceæ.

MYRRHA, 102.
Olibanum, 103.
Bdellium, 104.
Elemi, 105.

Meliaceæ.

Maregamia, 106.
Cocillana, 107.
Azedarach, 108.

Ilicineæ.

Ilex Opaca, 109.
Ilex Paraguayensis, 110.
Prinos, 111.

Celastraceæ.

EUONYMUS, 112.
Celastrus, 113.

Rhamnaceæ.

FRANGULA, 114.
RHAMNUS PURSHIANA, 115
Rhamnus Cathartica, 116.
Ceanothus, 117.
Gouania, 118.

Ampelideæ.

Uva Passa, 119.
Ampelopsis, 120.

Sapindaceæ.

GUARANA, 121.
Æsculus Glabra, 122.
Æsculus Hippocastanum, 123.
Acer Rubrum, 124.
Macassar Oil, 125.

Passifloreæ.

Carica Papaya, 216.
Passiflora, 217.

Cucurbitaceæ.

COLOCYNTHIS, 218
Bryonia, 219.
Luffa, 220.
Momordica, 221.
PEPO, 222.
Citrullus, 223.
Cucumis, 224.
Elaterium, 225.

Cacteæ.

Cactus, 226.
Anhalonium, 227.

Umbelliferæ.

ANISUM, 228.
OLEUM ANISI, 228 a.
FŒNICULUM, 229.
OLEUM FŒNICULI, 229 a.
CONIUM, 230.
Conii Folia, 231.
CARUM, 232.
OLEUM CARI, 232 a.
CORIANDRUM, 233.
OLEUM CORIANDRI, 233 a.
Anethum, 234.
Oleum Anethi, 234 a.
Apium, 235.
Ajowan, 236.
THYMOL, 237.
Petroselinum (root), 238.
Petroselinum (seed), 238 a.
Phellandrium, 239.
Cuminum, 240.
Carota, 241.
Angelica Atropurpurea, 242.
Angelica Officinalis, 243.
ASAFŒTIDA, 244.
Galbanum, 245.
Ammoniacum, 246.
SUMBUL, 247.
Imperatoria, 248.
Laserpitium, 249.
Levisticum, 250.
Pimpinella, 251.
Thapsia, 252.
Cicuta, 253.
Eryngium, 254.
Osmorrhiza, 255.

Araliaceæ.

Panax, 256.
Aralia Nudicauli, 257.
Aralia Racemosa, 257 a.
Aralia Hispida, 258.

Cornaceæ.

Cornus Florida, 259.
Garrya, 260.

Caprifoliaceæ.

Sambucus, 261.
VIBURNUM OPULUS, 262.
VIBURNUM PRUNIFOLIUM, 263.
Triosteum, 264.

Rubiaceæ.

IPECACUANHA, 265.
Rubia, 266.
CINCHONA, 267.
CINCHONA RUBRA, 267 a.
Remijia, 268.
Cephalanthus, 269.
Mitchella, 270.
Galium, 271.
Caffea, 272.
Catechu Pallidium, 273.

Valerianeæ.

VALERIANA, 274.
Oleum Valerianæ, 274 a.

Compositæ.

TARAXACUM, 275.
Cichorium, 276.
PYRETHRUM, 277.
Pyrethrum Germanicum, 277 a.
Pyrethri Flores, 278.
Inula, 279.
LAPPA, 280.
Lappæ Fructus, 281.
Polymina, 282.
Laciniaria, 283.
Helianthella, 284.
Echinacea, 285.
Arnicæ Radix, 286.
ARNICA, 287.
Cnicus Arvensis, 288.
Erechthites, 289.
Trilisa, 290.
Pterocaulon, 291.
Guaco, 292.
Ambrosia, 293.
Ambrosia Artemisiæfolia, 293 a.
Strumarium, 294.
Spinosum, 295.
EUPATORIUM, 296.
Eupatorium Purpureum, 297.
GRINDELIA, 298.
Tanacetum, 299.
Absinthium, 300.
Artemisia, 301.
Erigeron, 302.
Erigeron Canadense, 303.
OLEUM ERIGERONTIS, 303 a.

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* Natural orders in Italics and official drugs in bold-face type.

* Natural orders in Italics and official drugs in bold-face type.

MATICO, 460.
Yerba Mansa, 461.
Jambu Assu, 462.
Methysticum, 463.

Monimiaceæ.

Boldus, 464.

Myristiaceæ.

MYRISTICA, 465.
OLEUM MYRISTICÆ, 465 a.
Oleum Myristicæ Expressum, 465 b.
Macis, 466.

Lauraceæ.

CINNAMOMUM ZEYLANICUM, 467.
CINNAMOMUM CASSIA, 468.
OLEUM CINNAMOMI, 468 a.
CINNAMOMUM SAIGONICUM, 469.
SASSAFRAS, 470.
OLEUM SASSAFRAS, 470 a.
Sassafras Lignum, 471.
SASSAFRAS MEDULLA, 472.
Nectandra, 473.
Coto, 474.
Lindera, 475.
Laurus, 476.
Oleum Lauri, 476 a.
Umbellularia, 477.
CAMPHORA, 478.
OLEUM CAMPHORÆ, 478 a.
Persea, 479.

Thymelaceæ.

MEZEREUM, 480.

Santalaceæ.

Santalum Album, 481.
OLEUM SANTALI, 481 a.

Loranthaceæ.

Mistletoe, 482.

Euphorbiaceæ.

STILLINGIA, 483.
Euphorbia, 484.
  a. Euphorbia Corollata.
  b. Euphorbia Ipecacuanha.
  c. Euphorbia Pilulifera.
Euphorbium, 485.
Alveloz Milk, 486.
Mercurialis, 487.
ELASTICA, 488.
Lacca, 489.
Cascarilla, 490.
Ricinus, 491.
OLEUM RICINI, 491 a.
Tiglium, 492.
OLEUM TIGLII, 492 a.
Curcas, 493.
Kamala, 494.

Urticaceæ (*Moraceæ*, U. S. 1900).

† **ULMUS,** 495.
† **HUMULUS,** 496.
† **LUPULINUM,** 497.
† **CANNABIS INDICA,** 498.
Cannabis Semen, 498 a.
Oleum Cannabis, 498 b.
Urtica, 499.
† **FICUS,** 500.
Morus, 501.

Juglandaceæ.

Juglans, 502.

Myricaceæ.

Myrica, 503.
Comptonia, 504.

Cupuliferæ.

QUERCUS ALBA, 505.
Alnus, 506.
Fagus, 507.
GALLA, 508.
ACIDUM TANNICUM, 508 a.
ACIDUM GALLICUM, 508 b.
PYROGALLOL, 508 c.
Castanea, 509.
OLEUM BETULÆ, 510.
Ostrya, 511.

Salicaceæ.

Salix, 512.
Populus, 513.
Populus Balsamifera, 514.

Gnetaceæ.

Ephedra, 515.

Coniferæ.

SABINA, 516.
Juniperus Virginiana, 516 a.
OLEUM SABINÆ, 516 b.
Pinus Strobus, 516½.
Thuja, 517.
Juniperus, 518.
OLEUM JUNIPERI, 518 a.
OLEUM CADINUM, 519.
Tsuga, 520.
Larix, 521.
† **TEREBINTHINA,** 522.
Venice Turpentine, 522 a.
OLEUM TEREBINTHINÆ, 522 b.
† **RESINA,** 522 c.
† **PIX LIQUIDA,** 523.
† **OLEUM PICIS LIQUIDÆ,** 523 a.
TEREBINTHINA CANADENSIS, 524.
Pix Canadensis, 525.
Pix Burgundica, 526.
Succinum, 527.
Oleum Succini, 527 a.
Dammara, 528.

Kauri, 529.
Sandaracca, 530.

Orchidaceæ.

CYPRIDEDIUM, 531.
Corallorrhiza, 532.
Salep, 533.
VANILLA, 534.

Scitamineæ.

† **ZINGIBER**, 535.
Galanga, 536.
Zedoaria, 537.
Curcuma, 538.
† **CARDAMOMUM**, 539.
Granum Paradisi, 540.

Bromeliaceæ.

Ananassa, 541.

Hæmodoraceæ.

Aletris, 542.

Irideæ.

Iris, 543.
Iris Florentina, 544.
Crocus, 545.

Dioscoraceæ.

Dioscorea, 546.

Liliaceæ.

SARSAPARILLA, 547.
CONVALLARIA, 548.
VERATRUM, 549.
Veratrum Album, 549 a.
Sabadilla, 550.
Polygonatum, 551.
Chamælirium, 552.
Trillium, 553.
Asparagus, 554.
Allium, 555.
SCILLA, 556.
COLCHICI CORMUS, 557.
COLCHICI SEMEN, 558.
ALOE, 559.
Aloe Socotrina, 559 a.
Aloe Barbadensis, 559 b.
Aloe Capensis, 559 c.
Xanthorrhœa, 560.
Erythronium, 561.

Palmæ.

Areca, 562.
SABAL, 563.
Carnauba, 564.
Draconis Resina, 565.
Oleum Palmæ, 566.
Oleum Cocois, 567.

Aroideæ.

† **CALAMUS**, 568.
Symplocarpus, 569.
Arum, 570.
Arisæma Dracontium, 571.
Commelina, 572.

Cyperaceæ.

Carex, 573.
Adrue, 574.

Gramineæ.

TRITICUM, 575.
Vetiveria, 576.
SACCHARUM, 577.
ZEA, 578.
Oleum Maydis, 579.
AMYLUM, 580.
- a. Avenæ Farina.
- b. Sago.
- c. Tapioca.
- d. Taro.
- e. Triticum Vulgare
- f. Oryza.
- g. Solanum Tuberosum.
- h. Canna.
- i. Maranta.
- j. Curcuma Leucorrhiza.

Hordei Fructus, 581.
- a. Hordeum.
- b. Maltum.

Equisetaceæ.

Equisetum, 582.

Filices.

ASPIDIUM, 583.
Adiantum, 584.
Cibotium, 585.
Osmunda, 586.
Polyodium, 587.

Lycopodiaceæ.

LYCOPODIUM, 588.

Polytricaceæ.

Polytrichum, 589.

Lichenes.

Cetraria, 590.
Litmus, 591.
- a. Orchil.
- b. Cudbear.

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* Natural orders in Italics and official drugs in bold-face type.

Fungi.

† **ERGOTA**, 592.
Ustilago, 593.
Agaricus Albus, 594.
Agaricus Chirurgorum, 594 a.
Torula, 595.

Algæ.

† **CHONDRUS**, 596.
Fucus Vesiculosus, 597.
Fucus Nodosus, 597 a.
Laminaria, 598.

Animal Drugs.

CANTHARIS, 599.
COCCUS, 600.
Blatta, 601.
Hirudo, 602.
Spongia, 603.
Corallium, 604.
Testa, 605.
Os Sepiæ, 606.
Calculi Cancrorum, 607.
Ichthyocolla, 608.
Ambra Grisea, 609.
OLEUM MORRHUÆ, 610.
CETACEUM, 611.
MEL, 612.
CERA FLAVA, 612 a.
CERA ALBA, 612 b.
Ovum, 613.
a. Testa Ovi.
b. Albumen Ovi.
c. Vitellus.
MOSCHUS, 614.
FEL BOVIS, 615.
a. **FEL BOVIS PURIFICATUM.**
Sanguis, 616.
Lac, 617.
a. Butyrum.
b. Casein.
c. **ACIDUM LACTICUM.**
d. **SACCHARUM LACTIS.**
Os, 618.
GELATINUM, 619.
SEVUM PRÆPARATUM, 620.
Oleum Bubulum, 621.
ADEPS, 622.
OLEUM ADIPIS, 622 a.
PEPSINUM, 623.
PANCREATINUM, 624.
ADEPS LANÆ HYDROSUS, 625.
Hydrocarbon Fats and Oils, 625 a.
Hyraceum, 626.
Castoreum, 627.
Civetta, 628.
GLANDULÆ SUPRARENALES, 630.
GLANDULÆ THYREOIDEÆ, 631.

Bacterial Products.

Antitoxic Serums, 629.

The changes made in the U. S. P. of 1900 place the following drugs in families as indicated:

Krameria	Krameriaceæ.
Coca	Erythroxylaceæ.
Granatum	Punicaceæ.
Lobelia	Campanulaceæ.
Ulmus	Ulmacæ.
Humulus	Moraceæ.
Lupulin	"
Cannabis Indica	"
Ficus	"
Terebinthina	Pinaceæ.
Resina	"
Pix Liquida	"
Oleum Picis Liquida	"
Zingiber	Zingiberaceæ.
Cardamomum	"
Calamus	Araceæ.
Ergota	Hypocreaceæ.
Chondrus	Gigartinaceæ.

* Natural orders in Italics and official drugs in bold-face type.

SECTION III.—(B.)—DRUG ASSAY PROCESSES.

In the former part of this work (p. 77) we have given a list of crude drugs and their preparations, and the required official strength of each to be determined by assay. The Pharmacopœia gives in detail the various processes suited to the assay of the various drugs specified. By careful manipulation, using these methods, the pharmacist may reach definite results as to the quality and strength of the article under examination. The student in pharmacy should be familiar with the general principles which underlie the process of drug assay. A brief outline of these principles may be here in place.

Principles of Alkaloidal Assay.—The immiscible solvents, such as chloroform, ether, benzol, amylic alcohol, etc., are employed. Any of these liquids, when shaken with water or acidulated water, will mix with the aqueous liquid only for a time. On standing for a few minutes they will separate into two distinct layers, one of these being the aqueous layer, the other the immiscible solvent (mostly ethereal in character).

If equal volumes of ether and water be shaken together and a solution of the extract of belladonna added to the mixture and a few drops of sulphuric acid, it will be found that the belladonna alkaloids will be dissolved out and will be contained in the aqueous (acidulated) layer, *not in the ethereal layer*, because it is the general property of alkaloidal salts to be soluble in water, and to be insoluble in ether. The acid having converted the atropine and the hyoscyamine of the extract into a salt (sulphate), it therefore will be taken up and retained by the aqueous layer. If to these two liquids (the ether and the acidulated solution of the alkaloidal salt) there is now added a sufficient quantity of ammonia water to neutralize the acid and make the aqueous liquid slightly alkaline, and the fluids be again mixed and allowed to stand as before, it will be found that the alkaloids (of belladonna) are no longer in the aqueous layer but in the upper (ethereal) layer. It is the general property of free alkaloids, themselves, with few exceptions, to be soluble in ether (chloroform, etc.) and to be insoluble in water. It might be stated therefore, as a general principle, that alkaloids, as a rule, are soluble in the immiscible fluids (ether, chloroform, amylic alcohol), etc., while their salts are insoluble in these fluids. Alkaloidal salts, on the other hand, are insoluble in the immiscible fluids, but are soluble in water. Advantage is taken of this property in the assay of alkaloidal drugs.

As an illustration of the foregoing principle we would quote the first part of the process for the assay of fluidextract of Ipecac.

The official formula is about as follows:

Fluidextract of Ipecac, ten cubic centimeters (10 Cc.),
Normal Sulphuric Acid Solution,
Ammonia Water,
Ether,
Tenth-normal Sulphuric Acid Solution,
Fiftieth-normal Potassium Hydroxide Solution,
Hematoxylin Test Solution, each a sufficient quantity.

Measure off 10 Cc. of Fluidextract of Ipecac, in a measuring cylinder or a graduated pipette, and pour it into a porcelain evaporating dish. Evaporate off all the alcohol on a water-bath, and when almost cool, add 5 Cc. normal sulphuric acid, and stir until all the alkaloids have been dissolved. Filter off the undissolved portion through 7 Cm. plain filter into a separator. Wash the dish and the filter twice with 5 Cc. of distilled water, and add the wash-water to the separator. To the separator, add 20 Cc. of ether, make alkaline with ammonia water, and shake for three minutes. Draw off the lower portion into a beaker, and the ethereal layer into another beaker. Return the aqueous solution to the separator, and shake with 10 Cc. more of ether, adding the ethereal solution to that already in the beaker. After again returning the aqueous solution to the separator, shake again with 10 Cc. of ether, and then add the ethereal layer to that already in the beaker. Allow all of the ether to evaporate spontaneously or on a moderately warm water-bath.

The residue, when dried to constant weight, will contain the crude alkaloids of Ipecac.

The remainder of the official process consists in titrating this residue against a tenth-normal volumetric solution of sulphuric acid, using hematoxylin test solution as indicator.

Estimation of the Strength of Resinous Drugs.—In estimating the resinous drugs another procedure is necessary. Sometimes one can simply thoroughly extract the drug by means of alcohol; take an aliquot portion of the alcoholic solution and evaporate it to a small bulk; add water to precipitate the resin; decant the supernatant liquid and dry the residue to constant weight. From this weight of resin the percentage may be computed. This is a rather crude way, but the Pharmacopœia gives a more accurate assay process for the estimation of Jalap, which reads about as follows:

"Jalap should contain not less than 8 per cent. of total resin, nor more than 1.5 per cent. of ether-soluble resin.

"ASSAY OF JALAP.

Jalap, in fine powder (No. 60), ten grams (10 Gm.),
Ether,
Alcohol,
Chloroform,
Distilled water, each, a sufficient quantity

"Plug the tube of a funnel or small glass percolator with absorbent cotton, and put into it 10 Gm. of powdered Jalap. Drench with ether and percolate with ether, after covering the percolator, until 50 Cc. of percolate have been obtained. Evaporate off the ether from a tared beaker, and weigh the residue as ether-soluble resin. The weight so found multiplied by ten will give the percentage of ether-soluble resin in the drug.

"Percolate the powder in the percolator further with alcohol until 100 Cc. of percolate have been obtained. Measure off 20 Cc. of this percolate into a separator, add 20 Cc. of chloroform, and mix. Then add 20 Cc. of distilled water, shake the liquids thoroughly for a minute, and when they have completely separated, draw off the chloroform into a tared beaker. Wash the separator with 5 Cc. more of chloroform, which add to a tared beaker. Evaporate off the chloroform on a water-bath, and when perfectly dry, weigh. The weight of ether-insoluble resin so found multiplied by fifty will give the percentage of ether-insoluble resin in the drug. Add to this the percentage of ether-soluble resin already determined, and the result will be the percentage of total resin contained in the drug."

PART III.

INSECTS INJURIOUS TO DRUGS.

The introduction of this brief appended section on insects injurious to drugs into a text-book of materia medica, while an innovation, seems desirable to the author of the text-book on the ground of the importance of the subject. It is a fact that stored drugs are attacked by a considerable number of insects, and that a varying amount of loss from this cause is sustained by practically every druggist, wholesale and retail, in the land. If, by the acquiring of a little knowledge of the appearance and habits of these pests, and by the exertion required in a little preventive or remedial care, this loss can be lessened, the introduction of this section, which attempts to furnish the information necessary for the little knowledge and the little care, will be justified.

The necessary entomological knowledge of the pharmacist who would make some show of resistance to the insect enemies of his drugs may be limited to an acquaintanceship with these insect enemies, and a knowledge of the means of fighting them. As a basis for this acquaintanceship, however, it is necessary to glance hastily at the great class of insects in general. More numerous in species and individuals than all other animals combined, the insects are conveniently divided into several great groups or orders. All the butterflies and moths, whose wings are covered with fine scales, and who obtain their food by sucking the nectar from flowers, constitute one order; the beetles, with their horny fore-wings and their powerful jaws for biting, compose another order; the two-winged flies, of which the familiar house-fly is an example, constitute a third order; the ants, bees, and wasps, and some other highly intelligent insects are grouped together in a fourth order; the true bugs, as the chinchbug and squash-bug, with their sucking beaks, are comprised in a fifth order; the grass-hoppers, crickets, cockroaches, and katydids compose a sixth order; and, finally, the gauzy-winged dragon-flies, the short-lived May-flies, and the wonderful white ants constitute a seventh order. But a simpler division of insects into two great groups is that often made, for convenience' sake, especially by the economic entomologist; namely, a division made according to mouth parts, all insects in the adult stage having mouth parts fitted

for biting or mouth parts fitted for sucking. It is evident at once that the pharmacist will be especially interested in the biting insects, the ones which can attack roots and leaves, and all dry preparations. There will be little opportunity for the sucking insects to injure the pharmacist's stores. The insects may be divided according to this distinction as follows: The orders containing the beetles, the cockroaches, the dragon-flies, etc., compose the group of biting insects; the orders containing the true bugs, the butterflies and moths, and the flies, compose the group of sucking insects; while the order of the ants, bees, and wasps, and the order of mites (which are not true six-footed insects, but are closely related to them) may be said to compose a third group, in which the mouth parts are arranged for both biting and sucking, or piercing and sucking.

But we can not thus dismiss certain of the sucking insects from our pharmaco-entomological consideration; for with wonderful adaptiveness, nature has arranged that the young of certain sucking insects shall be provided with jaws for biting. The common worm-like caterpillars, which are the larval forms, or young, of butterflies and moths, are familiar to all; most children know that the strong-jawed, foliage-eating "worm," now feeding so voraciously on the green leaves of plant or tree, will in time change into some beautiful four-winged butterfly or moth, incapable of injuring a green leaf, and taking its food only in dainty sips, by means of its sucking tubular mouth parts, from some bright flower. And most housewives know that the dreaded clothes-moth—little, brown, delicate flutterer—is, in its moth or winged stage, harmless to furs or woolens, but that the dreadful little white grub, with its sharp jaws and voracious appetite, which really does the damage, is only the young of the innocent-looking moth, and that the moth, after all, is not so innocent.

So, then, it behooves the pharmacist to keep an eye on not only those insects which all their lives are truly biting insects, but also on those insects, as the moths, which, while harmless as adults, yet in their young stages, with strong biting mouth parts, appear as ravaging caterpillars.

In setting out to fight an insect pest, the economic entomologist asks first, "What is it? Is it a beetle, or a fly, or a moth?" This question answered, he already knows much about it; whether, for example, it is a biting or a sucking insect; he knows in a general way what sort of damage it does and how it does it, and he knows, too, in a general way, what remedies are most likely to be effective in fighting it. But it is always better and usually necessary to know the exact life history of the particular pest he must fight; he must discover where and when its eggs are laid, how long it remains in the larval or grub stage, what are its times and places of feeding, and what are its favorite articles of diet. From this

life history he can decide on the character of the remedy to be applied, and when and where the remedy can best be used. Therefore the pharmacist may wisely turn to his jars and boxes, his store-rooms and laboratories, and try to discover what manner and number of insects he is to array himself against.

Referring to some of the more common and destructive pests attacking stored drugs, the mites (order, Acarina) may first be noted. The mites, commonly enough represented and known in the case of the familiar flour or cheese mite, are minute, rounded-oval; eight-legged insects, with the mouth parts arranged to form a piercing beak. The body is not divided into head, thorax, and abdomen, as is the case with other insects, but all these parts are coalesced or merged into a single mass. While many mites suck the blood from animals or the juices from plants, many

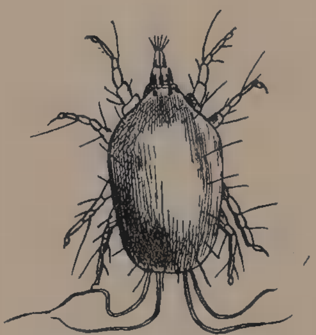

FIG. 264.—Sugar Mite.

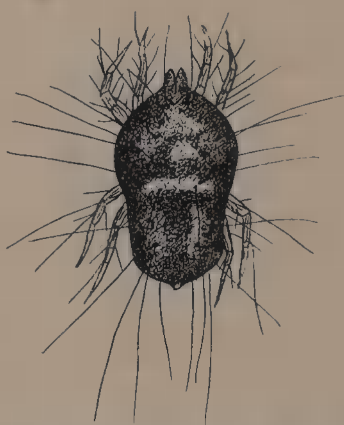

FIG. 265.—A Cantharid-eating Mite (*Glyciphagus spinipes*).—(*Fum. and Rob.*)

others feed on "dry food." Among these are the flour and cheese mites, and sugar mites with soft, smooth, whitish body (see Fig. 264), and belonging to the genera Tyroglyphus, Rhizoglyphus, and Glyciphagus. Many species of these genera of mites, besides being found in sugars, meals, and other vegetable products in the store-room, attack dried animal remains, cantharides suffering severely from the ravages of several species of *Glyciphagus* (see Fig. 265). The presence of the mites in the cantharides jars is indicated by much powder and broken bits of the beetles gathering on the bottom of the jars. In this mass of powder and fragments can be seen with the naked eye many small, moving, whitish specks, the mites. These specks, examined under the microscope, will reveal the characteristic shape and appearance of the mites.

The most abundant pest in the pharmacal store-rooms appears to be a small brown beetle, *Sitodrepa panicea*, belonging to the family Ptinidæ,

a family whose members, in both larval and adult stages, feed on dead, dry vegetable and animal matter. This family comprises a number of small beetles, rarely exceeding a quarter of an inch in length, and usually brownish in color. A conspicuous and distinctive character is the hood-like prothorax, the head being so bent or drawn back under it as to be almost concealed (see *b*, Fig. 266). *Sitodrepa panicea*, the especially abundant species of this family, is from two to three mm. long, with a brown, subcylindrical body. It is almost entirely covered with many fine, short, yellowish hairs, which, on the upper surface of the body, are arranged in parallel longitudinal lines; the upper surface of the body (strictly, only the wing-covers) is finely striated (see *a*, Fig. 266). The head is

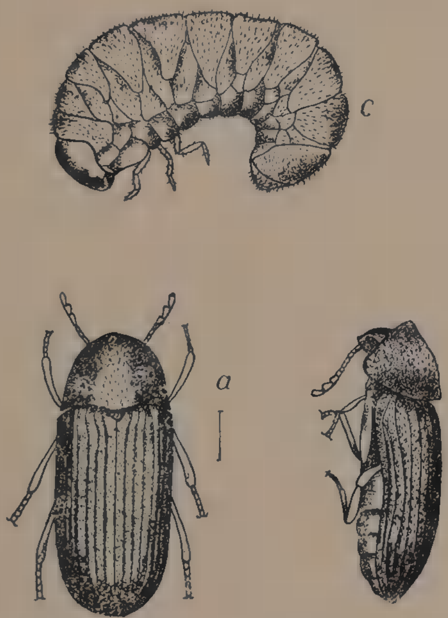

FIG. 266.—*Sitodrepa panicea* Linné. The common drug-eating insect. *a*. Dorsal view of adult beetle. *b*. Side view of adult beetle. *c*. Larva.—(*Smith*.)

FIG. 267.—Ginger root attacked by *Sitodrepa panicea* Linné.—(*Original*.)

almost concealed by the thorax, the front margin of the thorax reaching to the eyes. The head is also bent strongly downward. The young, or larva, of this beetle is a small white grub with three pairs of legs, and strong, dark brown jaws. The grub when lying at rest usually assumes a semicircular position (see *c*, Fig. 266). They feed voraciously on the drug, grow rapidly, and, after two or three weeks, pupate, and soon change into the perfect beetle. The beetle also feeds upon the drug by means of strong biting jaws, and the females soon lay eggs, from which another generation of larvæ, or grubs, hatch. The whole life of the insect is thus passed in the can or jar containing the drug. The presence of the pest is shown by the collecting of a considerable amount of powder on the bottom of

the can or jar (if the drug is a root, stem, or leaf), and by the presence in the drug of many small holes eaten by the insects (see Fig. 267). Often the little brown beetles may be seen crawling about in the jar. If the drug is a powder, this is the easiest means of detecting their presence. *Sitodrepa panicea* is almost omnivorous in the pharmacal store-room. In the store-rooms of the department of pharmacy, University of Kansas, *Sitodrepa panicea* has been found feeding on such drugs as the following: Columbo, aconite, mustard, althæa, belladonna, poke root, ginseng, angelica, etc.

Still other species of the family Ptinidæ feed on drugs: *Lasioderma serricorne*, a small brown beetle very like *Sitodrepa panicea*, but more robust, and with the wing-covers smooth and not striated, although covered with fine hairs as in *Sitodrepa*, is not uncommon. The larva or grub is like the grub of *Sitodrepa*, and the habits are about the same. I have found *Lasioderma serricorne* attacking powdered ergot, and Prof. J. B. Smith, entomologist of Rutgers College, has found it attacking belladonna root. *Ptinus brunneus*, another species of the family, which I have found attacking musk root, powdered senna, and powdered jaborandi leaves, differs considerably in appearance from the other two members of the family just referred to. It is slightly larger, being about four mm. long, and it has long, slender antennæ or feelers which project forward from the head (see Fig. 268). The antennæ of *Sitodrepa* and *Lasioderma* are usually bent back upon the body. The body of *Ptinus* is not subcylindrical, but tapers toward the head, the head itself being much narrower than the body. *Bostrichus dactilliperda*, another member of the family Ptinidæ, attacks sweet almonds.

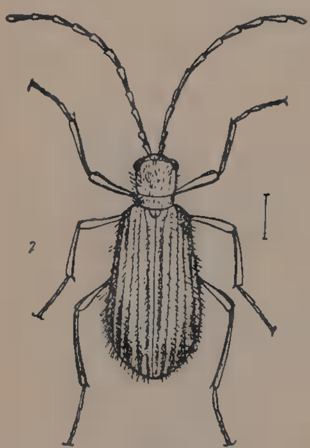

FIG. 268.—*Ptinus brunneus* Duft. —(*Riley*.)

Another family of beetles which includes several drug-attacking species is the Dermestidæ. To this family belongs the common buffalo bug (*Anthrenus scrophulariacea*) of the house. The Dermestidæ comprise a number of beetles, mostly small, which feed on skins, furs, various dried animal substances, and, to some extent, on dried vegetable substances. *Anthrenus varius*, which I have found in jars of powdered cramp bark and fenugreek, is small, rounded-oval, with transverse black, white, and reddish-brown waved stripes (see *a*, Fig. 269). The grub differs from the larvæ of the Ptinidæ in bearing many long, bristly hairs (see *c*, Fig. 269). The adult beetle lives chiefly upon the pollen of certain plants, but the larva or grub lives indoors, and, feeding on rugs, woolen goods, collections of natural history, furs, hairs, and drugs, is a serious pest.

Another family of small beetles, the Cucujidæ, is represented among drug pests by several species of the genus *Silvanus*. The beetles belonging to this genus are about one-tenth of an inch long, light-brown, flattened, and with antennæ clubbed at the tip (see Fig. 270). I have found *Silvanus surinamensis* attacking almond meal, *Silvanus advena* feeding on aconite root, and another species of *Silvanus* attacking angelica seed, quince seed, bitter-sweet, senega root, hyoscyamus, pellitory root, etc.

A large black beetle, *Tenebrio obscurus* (family Tenebrionidæ), is sometimes found attacking drugs. I have taken it in jars of parsley root. It is three-quarters of an inch long, dull black all over, with bead-like antennal joints, and with narrow, parallel, longitudinal ridges along the wing-covers. A small, shining, black beetle (genus *Paromalus*), belonging to the family Histeridæ, has been found in powdered poke root. Two species of *Ceutorynchus*, small snouted beetles or weevils, infest poppy and

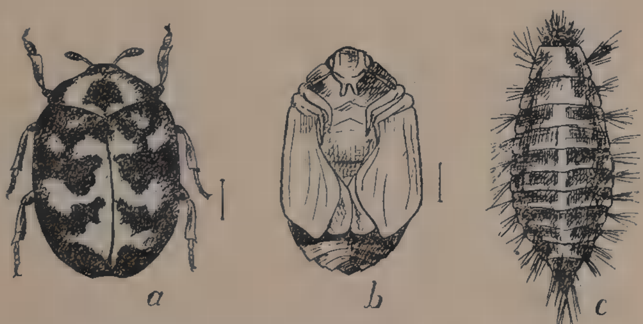

FIG. 269.—*Anthrenus varius* Fab. *a*. Adult beetle. *b*. Pupa. *c*. Larva.—(*Original*.)

FIG. 270.—*Silvanus surinamensis* Linné. —(*Original*.)

other seeds. Another weevil, *Calandra oryza*, imported from Europe, infests rice and ground roasted acorns.

The beetles comprise the chief drug pests, but some other orders of insects are represented by a lesser or greater number of pests.

The Lepidoptera or butterflies and moths, while possessing, in the adult stage, mouth parts adapted for sucking, have, in the young stages, strong biting-jaws. The young are the well-known caterpillars, and may be distinguished from the young or grubs of beetles by the number of legs. The larva or grub of the beetle has but three pairs of legs, and these are attached to the first three segments of the body lying just behind the head; the larva or caterpillar of a moth has, in addition to these three pairs of so-called thoracic legs, usually five more pairs of legs, four of these pairs being attached to segments in the middle region of the worm-like body, and the fifth pair being attached to the last segment of the

body. The grubs of beetles sometimes have in addition to their three pairs of thoracic legs a *single* leg on the last segment of the body.

Every one knows of the clothes-moth, dread foe of the housewife, which, as a small white caterpillar, living in a cylindrical roll or case (see *d*, Fig. 271) made from the woolen cloth or fur on which it is feeding, does irreparable injury to the choicest fabrics and costliest furs. This moth belongs to the genus *Tinea*, of which one or more species attack drugs. Fig.

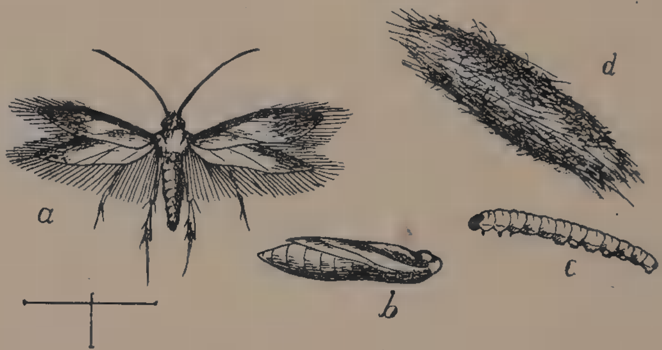

FIG. 271.—*Tinea penionella* Linné. *a*. Adult moth. *b*. Pupa. *c*. Larva. *d*. Case.—(*Original*.)

271 illustrates the life history of the moths of this genus; *c* is the larva or caterpillar; *b* is the pupa or resting stage; and *a* is the adult moth. The moth is very small and light-brown in color. I have found a Tineid attacking aconite root. Another moth, known as the Angoumois grain moth (*Gelechia cerealella*), attacks, in the caterpillar stage, all kinds of stored grain. It bores holes into the grain kernels and eats out the starchy interior, leaving only a delusive hollow shell. Figure 272 shows the

FIG. 272.—Grain kernels attacked by *Angoumois grain moth*. *a*. Infested kernel of corn. *b*. Kerne of corn cut open showing feeding larva within. *c*. Infested kernel of wheat.—(*Original*.)

appearance of the infested grain kernels. The larva of *Carpocapsa amflana*, a moth of the same genus as the codlin moth, the greatest insect pest of the apple, infests the seeds of *Corylus avellana*, *Juglans regina*, and *Castanea vesca*. The larva of *Mylois ceratonia* feasts on the fruits of *Ceratonia siliqua* and *Castanea vesca*. The larva of the moth *Œcophaga olivella* inhabits the kernels of the olive, causing the dropping of the fruit and a smaller yield of oil.

Passing now to another order of insects, the two-winged flies, we find

that while the mouth parts of the adult flies are adapted for sucking or lapping, the young flies, which appear as grubs or maggots, are in many cases better prepared to partake of solid food. The olive in southern France and Italy is infested by a larva of a fly known as *Dacus oleæ;* in the kernels of fresh hazelnuts are often found the larvæ of a fly which belongs to the same genus as that notorious wheat pest, the Hessian fly. The fly *Trypeta arnicivora* is often gathered in its youthful state with arnica flowers, and becomes developed later on, after feeding on the flowers in the pharmacist's canisters.

The book-louse insects (genus *Atropos*) have at least one representative in the list of drug pests. I have found a species (probably *divinatoria*)

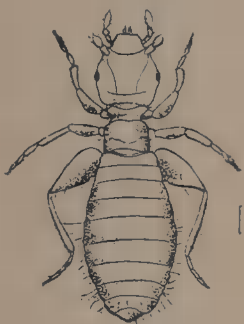

FIG. 273.—*Atropos divinatoria* Fab.—(*Orignal.*)

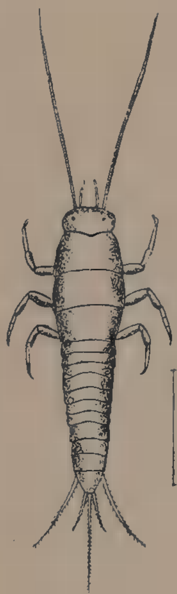

FIG. 274.—*Lepisma saccharina* Linné. — (*Walker.*)

FIG. 275.—*Cynips.*—(*Original.*)

of this genus attacking golden seal and hyoscyamus. The insect is very small, hardly a twentieth of an inch long. When examined with a microscope it is found to be wingless, and of a general appearance as shown in Fig. 273. This insect represents the family Psocidæ, of the order Pseudoneuroptera.

The order of wingless insects *Thysanura*, which includes the "fish-moths," those active scale-covered little creatures of the household, is represented by a member of the genus *Lepisma* (probably *saccharina*) (see Fig. 274), which I have found in jars of mezereon bark and Socotrine aloes.

Finally, in jars of gall the pharmacist may find numerous little four-winged, compact-bodied "flies," which are not, however, attacking his

stores, but which are only the insects which produced the galls, now issuing from them. These little insects (see Fig. 275) are Hymenoptera, belonging to the genus *Cynips*. The pharmacist may find other Hymenoptera (distinguished by having four clear membranous wings with almost no veins in them, see Fig. 275) in his jars and cans; but these insects are his benefactors. They are parasitic on the beetles and other insect pests which are feeding on the drugs, and thus do much good. Their eggs are laid on the body of the grub of the drug-eating beetle, and the young hymenopteron, on hatching, eats its way into the beetle-grub and lives there at the expense of its host.

REMEDIES.

Coming now to the matter of remedies, a reviewing of the notes thus far presented shows that beetles are the most serious and numerous of drug pests, and that practically only insects which have biting mouth parts are injurious. In fighting insects with biting mouth parts the common means employed by entomologists is to cover the substance attacked (usually the green foliage of plants) with a thin coating of arsenic, by means of spraying. In the nature of the case this method is out of the question in fighting drug pests, but, because the drugs are capable of being easily handled and subject to treatment in air-tight vessels, a very convenient, effective, and universally applicable method is possible, namely, treatment with vapor of bisulphide of carbon. The vapor of bisulphide of carbon is deadly to all insects in all stages, except the egg stage. The infested drug should be placed in a tight vessel (after having removed the dust and debris caused by the attacks of the insects) and a quantity of bisulphide of carbon, sufficient to charge the vessel with vapor, introduced. Any insect in the vessel will be killed. The remedy is simple, effective, and is feasible in the case of almost any drug.

Prevention of attack may be accomplished in some degree by the use of tight cases, though often the insects are introduced into the case with the drug, the drug specimens having come from an infested lot. Occasionally inspection of the jars and cans will detect the insects before they have had time to do much damage.

The case of the detection of the presence of insects, and the ease with which the pests may be killed, makes it certainly worth the while of any druggist to devote the little time required for the effective prevention of insect damage to his stores.

PART IV.

ELEMENTS OF PLANT HISTOLOGY AND MICROTECHNIC.

CHAPTER I.—SELECTION AND USE OF APPARATUS FOR USE IN VEGETABLE HISTOLOGY.

THE MICROSCOPE.

The Continental type of microscope manufactured by the Spencer Lens Co., Buffalo, N. Y., and by Bausch & Lomb, Rochester, N. Y., gives excellent service in histological work. The Spencer Continental form No. 3, equipped with a double nosepiece, a $\frac{2}{3}$ and $\frac{1}{6}$ inch objective, and a 1 inch eyepiece, will be found adequate for the needs of the pharmacist, unless bacteria are to be studied, in which event an oil-immersion objective and an Abbe condenser should form a part of the microscope equipment. The Spencer Continental form No. 1 and the Bausch and Lomb AAB and BB stands are suitable for work of this character.

Excellent microscope outfits may also be obtained in Germany from Carl Zeiss, Jena, Ernst Leitz, Wetzlar, and from C. Reichert, Vienna, Austria, and Powell & Lealand, London.

The Use of the Microscope.—Starch from the potato will be found an excellent object for the first lessons in the use of the compound microscope.

Clean a glass slip by dipping it into water and wiping it dry with a clean towel or piece of old linen or cotton cloth; clean a cover-glass in the same manner, using great care not to break it. A safe way of wiping the delicate cover-glass is to fold the cloth between the thumb and forefinger, then place the cover-glass within the fold and polish it with a gentle movement to and fro of the thumb and finger. After the cover-glass is cleaned, it should not be touched on its faces with the fingers, but should always be picked up by its edge. After the cover-glass has been cleaned, it should always be placed on the edge until needed, for if its faces come in contact with anything at all unclean or dusty, it will need polishing again. The glass slip should also be kept scrupulously clean.

Put a small drop of water in the middle of the glass slip; cut open a potato, and with the point of a knife scrape the cut surface lightly and

transfer some of the juice which adheres to the knife to the drop of water on the slide. The beginner is apt to make the drop of water too large. The drop should be only large enough to fill out the space between the slip and cover-glass when the cover-glass has been placed over the drop. If the water is pressed out beyond the edge of the cover-glass, it is apt to carry with it the object to be studied, or to flow back over the upper surface of the cover-glass, and in this event the latter would need to be removed and again polished. After a little practice, the proper size of the drop for a certain diameter of cover-glass can be determined.

To put on the cover-glass, grasp it between the thumb and forefinger of the right hand and, holding it nearly vertically, rest the lower edge upon the slip to the right of, and near to, the drop. Lower the cover-glass over the drop, supporting it at its upper edge by means of a dissecting needle held in the left hand, and placing the middle finger of the right hand against the lower edge of the cover-glass to keep it from sliding backward toward the right. Lower the cover-glass slowly, taking care that no air-bubbles become entangled in the film of water; if danger of this is observed, move the glass up and down with the dissecting needle until the bubbles are broken and pass out. The bubbles should be broken in this way as they are seen to form. When the cover-glass is in position, if water is pressed out beyond the edge, it may be removed with a bit of filter paper; but if much water is to be removed, the object is apt to be drawn to the edge of the cover-glass or entirely from under it, and in such event the preparation should be made over again. When the preparation is finished, the cover-glass and slide should look as clear as a crystal; if they have become smirched in any way the preparation should be made anew and the cover-glass and slide repolished. The reason for this is that the object is to be examined with transmitted light,—that is, with light that has passed through the slip, object, and cover-glass from below,—and the transmission of the light, which is absolutely necessary to the observation of the object, is prevented by a dirty slide or cover-glass.

Place the slip on the stage of the microscope (see Fig. 276) so that the object under the cover-glass comes in the center of the opening in the stage; place the microscope in a position convenient for observation, keeping the microscope upright, and then adjust the mirror so that the light is reflected up through the object. When this is accomplished, a bright spot of light will be seen to illuminate the object. Thus far no attempt has been made to look through the microscope. When the mirror has been adjusted, the microscope should not be moved, else a readjustment of the mirror will be necessary. The microscope should therefore be placed in position and left there during subsequent manipu-

lations. Before putting the slip on the stage of the microscope the objective should be racked high up out of the way.

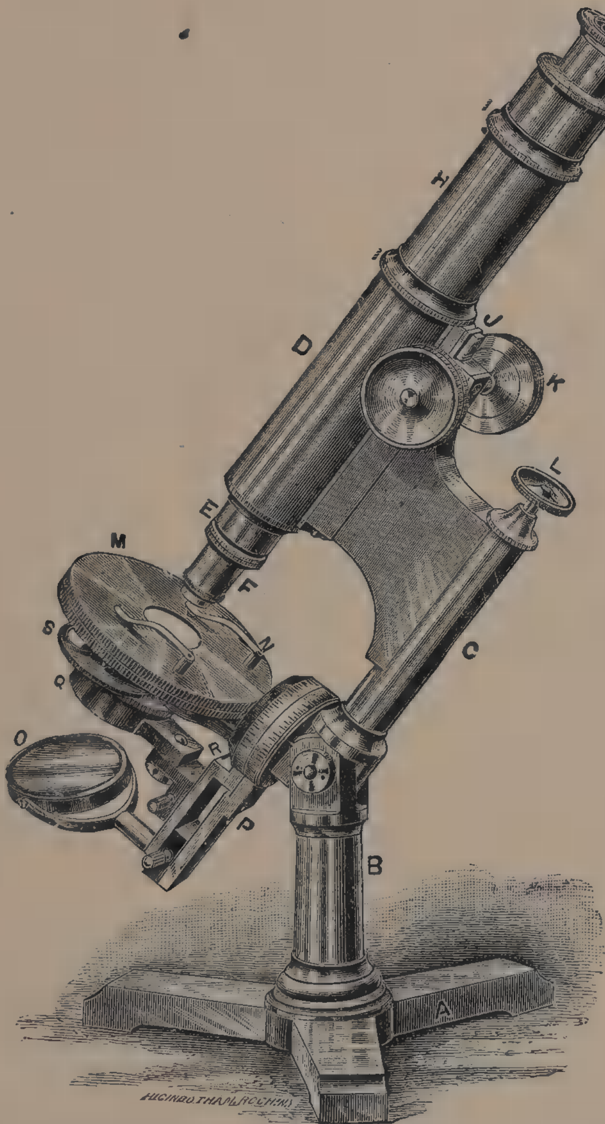

FIG. 276.—Compound Microscope. A. The base or foot. B. Pillar. C. The arm. D. The body, to which the optical parts are attached. E. Nosepiece. F. Objective. G. Eyepiece or ocular. H. Draw-tube. I. Collar. J. Coarse adjustment. K. Milled heads for operating the coarse adjustment. L. Fine adjustment, which acts upon the body directly or indirectly by means of a micrometer screw. M. Stage where the objects are placed for examination. N. Clips for holding in position the glass slides on which the objects are mounted. O. Mirror, one side of which is concave and the other plane; the concave mirror gives stronger illumination than the plane. P. Mirror bar. Q. Substage which carries the diaphragms and the condenser; in the cheaper forms of microscopes the substage is attached directly to the stage, but in the better forms, as in this instance, it is attached to the movable substage bar, R. S. The diaphragm, which may consist of a revolving disk with openings of various sizes, or the size of the openings in the diaphragm may be regulated by shutters constituting what is known as the iris diaphragm.

The high-power (namely, the $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{8}$, etc.) objectives are in focus —that is, are in position to form an image of the object at the right plane

for observation through the eyepiece—when the front lens is very close to, and almost touching the cover-glass. The $\frac{2}{3}$- and $\frac{3}{4}$-inch objectives are in focus when their front lenses are about $\frac{1}{2}$ of an inch from the cover-glass.

Proceeding with the examination of the starch preparation, the $\frac{2}{3}$ or other low-power objective will be first employed. Rack the objective down until within less than $\frac{1}{2}$ of an inch from the cover-glass, and then, looking through the microscope, slowly rack back until the object comes in view; then obtain a sharp focus by turning the micrometer screw (L, Fig. 276) to the right or left, as the case may require. It will be observed that the turning of the micrometer screw in the same direction as the hands of a watch carries the objective downward, while the reverse movement carries it upward.

If the mirror has been properly adjusted, the field of view will appear brightly illuminated; if the field is not bright, the mirror may be slightly moved about until the proper angle is obtained; but only a trifling adjustment should be necessary after the light has once been directed on the object, as described above.

If on racking the objective back the object does not come into view, the objective should again be lowered and the operation repeated. The caution should be given here, and borne in mind once for all, that never should one lower the objective while looking through the microscope, for the reason that the objective is apt to be run against the cover-glass before one is aware, breaking the cover-glass and even the slip, and sometimes injuring the objective. The objective should be racked back very slowly, else the plane of the focus may be passed without the image being seen.

If after proceeding as above the image has not been observed, the failure is probably due to the fact that the object has not been placed directly under the objective; in this event the object should be more accurately centered and the operation of focusing repeated. If difficulty is still experienced, the slip may be moved back and forth while the objective is being raised. Even if the object is not brought under the objective, in this way some fleck of dust on the cover-glass, or in the mounting medium, or even the edge of the cover-glass, may pass within the field of view, and by means of this the proper height of the objective may be approximately attained. The slip should then be moved about until the image of the object to be studied appears. The image is apt to be indistinct, or even a mere shadow, but still sufficiently discernible to be centrally adjusted, and then it may be brought sharply into view by means of the fine adjustment.

After the object has been accurately centered by means of the low

power, the tube may be racked back and the high power swung into position, assuming that a double or triple nosepiece (Fig. 277) is provided. If this is not the case, however, the low-power objective must then be unscrewed and the high power put in its place. In screwing on an objective it should be held in position between the thumb and forefinger of one hand, while the screwing motion is imparted by the thumb and forefinger of the other hand. To get the objective in exactly the right position for screwing it on, it is a safe plan to press the objective gently but steadily against its proper place in the nosepiece and then turn contrary to the direction of the movement of the hands of a watch until a clicking sound makes known that the threads of the tube and of the nosepiece are adjusted to each other, and then the opposite motion should be imparted. Without this precaution the objective may be started on while its threads and those of the nosepiece are not properly adjusted to each other, and an injury to the threads may result.

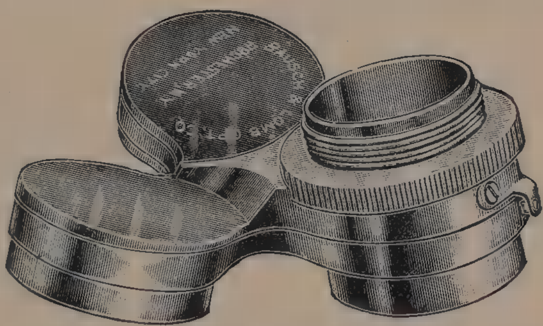

FIG. 277.—Revolving Triple Nosepiece. This may be screwed directly to the nosepiece, E, of Fig. 276.

With the high-power objective in position, rack down until the front lens of the objective nearly touches the cover-glass; then, while looking through the microscope, rack back very slowly until the image appears, and then focus it sharply by means of the micrometer screw.

It will be noticed that the full depth of even so small an object as a starch-grain is not in focus while the objective is in one plane; that while the upper surface is in focus the central portion and under surface are indistinct. The general outline of the starch-grain can therefore be best made out when the central portion is in focus—that is, when the edge of the grain appears sharply and without shadowy outlines.

The substage diaphragm (S, Fig. 276) is provided with openings of different sizes; the larger openings give greater illumination, and the smaller openings sharper definition. The size of the opening to be employed will depend upon the intensity of the source of light, the thickness of the object through which the light must be transmitted, and the power of the objective employed. The apertures of the diaphragm should therefore be shifted until the best results under the existing conditions are obtained.

If a substage condenser is employed, as will be necessary when oil-immersion objectives are in use, it must be raised and lowered after the

objective has been focused until the sharpest possible image has been obtained, and the diaphragm should be manipulated as before.

In the foregoing manipulations it is assumed that the microscope has been kept upright, although provided with a joint for inclination; for it is always best when examining objects in a fluid to keep the microscope erect, else the cover-glass may slide downward, or the object may constantly shift its position in the same direction. When permanent mounts in Canada balsam, glycerine jelly, or glycerine, after the cover-glass has been cemented down, are being examined, there is no objection to inclining the microscope. The microscope table should, however, be so low that an inclination of the microscope is not necessary.

Whenever possible the microscope table should stand before a north window. The light reflected from a bright cloud affords the best natural source of light for the microscope. Direct sunlight should never be used. If a northern exposure is not available, white curtains or white paper should be adjusted before the windows so that they may at the same time shut out the direct rays of the sun and serve as a source of illumination.

The concave side of the mirror should be employed when high powers are being used and there is no substage condenser on the microscope; when the microscope is provided with a substage condenser, however, the plane surface of the mirror should be used.

The mirror and the lenses of the objectives and eyepieces should be kept perfectly clean and bright.

If on looking through the microscope hazy spots or flecks of dust appear in the field, they may be located by revolving the eyepiece or the objective by slightly unscrewing it, or by moving the slip. If the dirt is on the eyepiece, it will appear to revolve with the eyepiece, and the same is of course true for the objective and slip. Such dirt may usually be easily removed by simply breathing on the glass where the dirt occurs and then wiping it off with a piece of old and soft linen or cotton cloth, using a circular motion on the eyepiece or objective. The lenses of the eyepiece and objective should never be touched with the fingers; if this should occur, breathe upon the lenses and wipe them off as directed.

When the source of light is known to be good, and the field of view is still poorly illuminated, the difficulty is due to the fact that the mirror is not set at the proper angle, or the diaphragm used is too small for the existing conditions, or there is dirt on the slide or lenses of the objective or eyepiece. The beginner should soon learn that cleanliness is an absolute necessity for success with the microscope.

If the moisture from the breath is not sufficient to clean the lenses, the cloth may be dipped into water, but the lenses should receive a final polishing with a dry portion of the cloth. The cloth used for the purpose should

be clean and kept in a place free from dust and grit. In wiping off the lenses of the eyepiece and objectives only a gentle pressure should be exerted, so that danger of scratching the lenses may be avoided.

When an oil-immersion objective is to be used, the object to be studied should be first accurately centered with a lower power, and then after the objectives have been racked back a small drop of immersion oil should be put on the front lens of the objective or on the cover-glass directly above the center of the substage condenser. The oil-immersion objective should then be swung into position and lowered until contact with the drop of oil is made; the objective may then be lowered a trifle more, but care must be exercised not to press it against the cover-glass; then while looking through the microscope the objective should be slowly elevated by means of the micrometer screw. The substage condenser should next be elevated or depressed until the image comes out sharpest, when the objective is accurately focused; the size of the opening in the diaphragm should also be varied until the best results are obtained. When the oil immersion is no longer in use, it should be gently but thoroughly wiped off with a clean and soft cloth; an old handkerchief serves admirably for this purpose.

An excellent artificial light for use with an oil-immersion objective may be arranged with a Welsbach burner as the source of light and a liter balloon-flask filled with ammonio-sulphate of copper to serve as a condenser and filter to eliminate the yellow rays. The solution for this condenser may be made by dissolving copper sulphate in distilled water and adding ammonia until all precipitate is dissolved and a perfectly clear blue solution results. Only a few small crystals of sulphate of copper will be necessary. The solution should be of such a depth of blue that the condenser projects a white image of the glowing Welsbach mantle upon a piece of white paper. The condenser should stand about eight inches from the lamp, and the microscope about the same distance from the condenser; the apparatus should be so adjusted that a sharp white image of the mantle falls upon the mirror of the microscope. A wooden base may be turned for the condenser or the condenser may be set upright in a tumbler. The condenser should be entirely filled with the solution, and a needle should be held beside the stopper while the latter is being pushed in, and then the needle should be withdrawn.

The objectives should always be racked back when a slide is being placed in position on the stage of the microscope or when it is being removed; in this way danger of injuring the preparation or the face of the objective is avoided.

At the outset the beginner should accustom himself to keeping both eyes open while looking through the microscope, and both eyes should

be employed in observation; if then the eyes are frequently shifted, they will not so soon become tired. There is usually some difficulty at first in keeping both eyes open while using the microscope, but the habit is soon acquired and is well worth the effort necessary at first.

When the microscope is not provided with a rack and pinion for the coarse adjustment, the tube should be raised and lowered with a spiral motion; or, if a double or triple nosepiece is attached to the tube, the motion should describe only segments of spirals to the right and left, downward or upward, as the case may require. A complete revolution of the tube is avoided, for the reason that the projecting arms of the nosepiece should be kept to the front.

After use, the microscope should be wiped off and put away in a place free from dust and injurious vapors.

The Use of Reagents.—In order to become better acquainted with the character of an object which is being studied with the microscope it is often desirable to treat the object with reagents after it has been mounted for observation, as described above. Starch, for instance, when treated with a tincture of iodine, will take on a blue or purple color. This may be demonstrated with the starch from the potato prepared as is elsewhere directed. After some of the starch-grains have been properly centered in the field of view and the objective has been sharply focused, a drop of tincture of iodine, prepared as described in the chapter on Reagents, should be put on the slide close to the right-hand edge of the cover-glass, but not touching it. Then the drop may be drawn up with a glass rod or a stick until it touches the cover-glass. The reagent is not put in contact with the cover-glass at first, lest the drop should overflow the cover-glass; in this event it would be best to wash off the slide and cover-glass and begin again. After the reagent comes in contact with the edge of the cover-glass a piece of filter-paper should be placed against the left-hand edge of the cover-glass, by which means the water will be drawn from under the cover-glass and the reagent drawn under in place of it. There should not at any time be a large quantity of water or reagent under the cover-glass or on the slide, but just enough to fill out under the cover-glass. The cover-glass should not appear to be borne up by the fluid. Unless too much fluid is present the starch-grains will not float away when one reagent is replaced by another, as above described.

Since the color imparted to the starch-grains should be watched as the reagent is being drawn under the cover-glass, some of the starch should be put into position for observation before the iodine is applied. The starch may take on a violet tint at first, but as the iodine continues to act, the color deepens to deep blue or purple, and finally to almost black. It is usually a good plan to watch the progressive action of a reagent in this way.

When an object is mounted in water, the water will soon evaporate from under the cover-glass, and accordingly a drop of water should be added from time to time in the manner described for the iodine, excepting that the filter-paper will not be necessary. The additional water should always be added on the side where the water is still in contact with the edge of the cover-glass, otherwise bubbles of air are apt to become entangled with the new supply of water as it passes under the cover-glass.

It is frequently useful when a mount has been made in water, and no other reagents are to be added, to place a drop of glycerine against the cover-glass on one side; as the water evaporates, it will be replaced by the glycerine. If other reagents are to be used, however, the glycerine should not be used, because it is difficult to replace. Glycerine has a tendency to clear up objects, and in many instances it is useful on this account, but objects which have no color of their own or which have not been stained are certain to appear, after a time, less distinct in glycerine than in water.

Other reagents will frequently be needed, as described in subsequent chapters, but except where otherwise specified they should be applied as already described.

Drawing from the Microscope.—The student should, from the beginning of his work in vegetable histology, make drawings of the structures seen with the microscope. This insures accurate observation and helps to a better understanding of the things observed.

Heavy linen ledger paper serves very well for a drawing surface, and Bristol-board is also well adapted for this purpose. The drawing paper should be of such a character that it can stand erasure without roughing up.

The drawing pencil should be hard and free from grit, such as Faber's No. 6 or Koh-I-Noor HHHHHH. The pencil should always be kept quite sharp; a piece of No. 0 emery cloth may be used to bring the lead down to a fine point. The pencil should be rubbed back and forth on the emery, point foremost (a lateral motion would be apt to drag off a fine point as fast as formed).

A good eraser should also be provided, and a brush or a rubber sponge will also be found useful in brushing off the fine particles after erasure.

Before the drawings are begun the student should decide how many drawings he wishes to make on a single sheet of paper, so that they may be uniformly distributed.

The drawings do not, of course, need to be made of the same size as they appear under the microscope,—they made be made larger or smaller, as desired,—*but they must be in right proportion.* The small diameter of an object may, for instance, be assumed as the measuring rod, and then all

other dimensions should be made as many times greater or less than this as they actually appear. The size of the drawing should depend upon the amount of detail to be drawn. The scale of the drawing should be so large that when the smallest details are put in, they will stand out clearly and will not be so cramped and crowded together as to appear unintelligible. Suppose an object should appear under the microscope to be as large as a pin-head, and certain details of structure may still be made out clearly; the object may then be drawn with a diameter three or four times larger than its apparent diameter, otherwise the drawing may not be made to represent the details so clearly as they really appear.

Right proportion and right relative position of all the details should be the rule invariably followed. This becomes less difficult of accomplishment if some dimension of the object is assumed as the measuring rod, as above suggested.

The lines should first be made with a very light stroke of the pencil, so that they may be easily erased if necessary, and then, after all the details have been satisfactorily drawn, the lines may be retraced and made quite sharp.

Determination of Magnification and Use of Camera Lucida.—To determine the magnification of an objective with a certain eyepiece, a stage-micrometer is necessary. This is a glass slide with a scale graven on its surface, the smallest division on the scale being $\frac{1}{100}$ or $\frac{1}{1000}$ of an inch, or of a millimeter, as the case may be. Place the micrometer on the stage of the microscope and focus for the scale as one would for an ordinary object. To the right of and close against the microscope adjust a board or a pile of books to the height of the stage of the microscope, and on this place a sheet of white paper. Look into the microscope with the left eye, and at the same time look at the paper with the right eye; the image of the micrometer scale should then appear projected upon the paper. The beginner may find difficulty in doing this at first, but a little practice will bring success. With the sharp point of a lead-pencil mark off the divisions of the scale upon the paper, or with a pair of dividers space off the distance between the larger divisions of the scale. Then compare the distance thus spaced off with a rule graduated in inches or centimeters according as the micrometer is graduated in fractions of inches or centimeters respectively. Suppose, for instance, that $\frac{1}{100}$ of an inch on the micrometer is found to cover $2\frac{5}{10}$ inches on the paper, the amount of magnification will be found by dividing $2\frac{5}{10}$ by $\frac{1}{100}$, giving 250 as the result. In other words, the value of the magnified image of any portion of the scale is to be divided by the actual value of the same portion of the scale. In this way the magnifying power of the objectives, when combined with the different eyepieces, may be determined and written down for future use.

To determine the size of an object, the image of the object should be spaced off on paper, as described above for the micrometer scale; it is not necessary, however, to outline the whole object, but simply to space off those diameters whose values are desired. Then divide the values of the magnified diameters by the magnifying power of the combination of objective and eyepiece already determined. Suppose, for instance, that the diameter of the image is found to be $\frac{1}{2}$ of an inch, and the magnifying power of the combination is 500; the actual diameter of the object would be $\frac{1}{1000}$ of an inch. In making these measurements the paper on which the diameters of the images are spaced off should always be at the same height, or rather at the same distance from the eyepiece. One only needs to vary this distance to note that the farther the paper is from the eyepiece, the larger the image appears. A convenient way to keep this distance

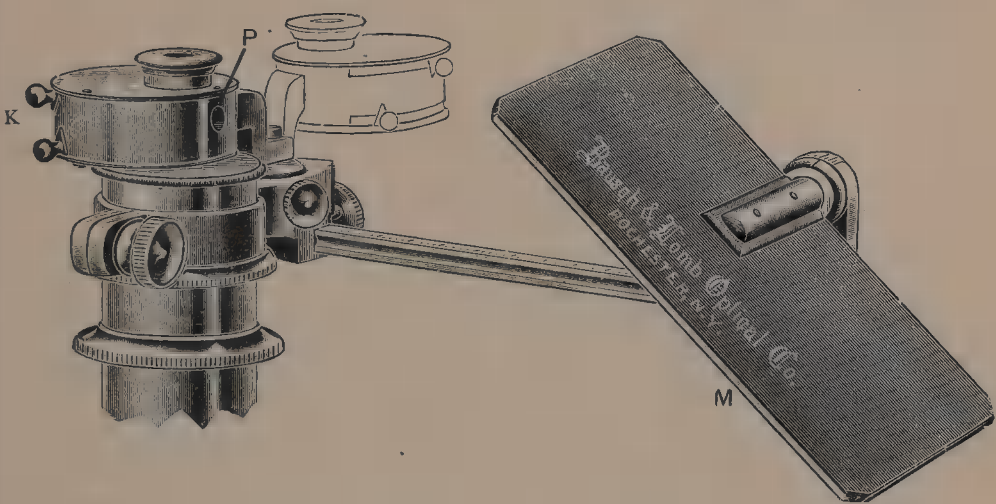

Fig. 278.—Abbe Camera Lucida. Description in text.

constant for measurements is to set the microscope upright and adjust the paper to the height of the stage of the microscope. If the microscope is provided with a draw-tube, as is likely to be the case, this should be entirely shoved in, or always drawn out to the same distance while the measurements are being made.

When a camera lucida is available, it will be found very useful in making measurements and in sketching in outlines.

The camera lucida illustrated by figure 278 is very complete in its adjustments. Simpler instruments may be obtained, however, which will give very satisfactory results. The essential structure of the above camera lucida will be made clear by reference to the figure. The light from the paper is reflected from the mirror, M, to the silvered surface of the prism behind the opening, P, and thence to the eye of the observer. A

small, round spot on the surface of the prism is left unsilvered, and through this the light passes from the object to the eye. Since by this arrangement both the object and the paper are seen at the same time, the object seems to be superimposed on the paper, and can therefore be traced with the sharp point of a lead-pencil. It is plain, however, that the light, entering the eye from both sources, must be of equal intensity, else the object and the pencil can not be seen with equal distinctness. If the pencil appears indistinct, the paper must receive greater illumination or the light which enters the eye from the object must be less intense. This

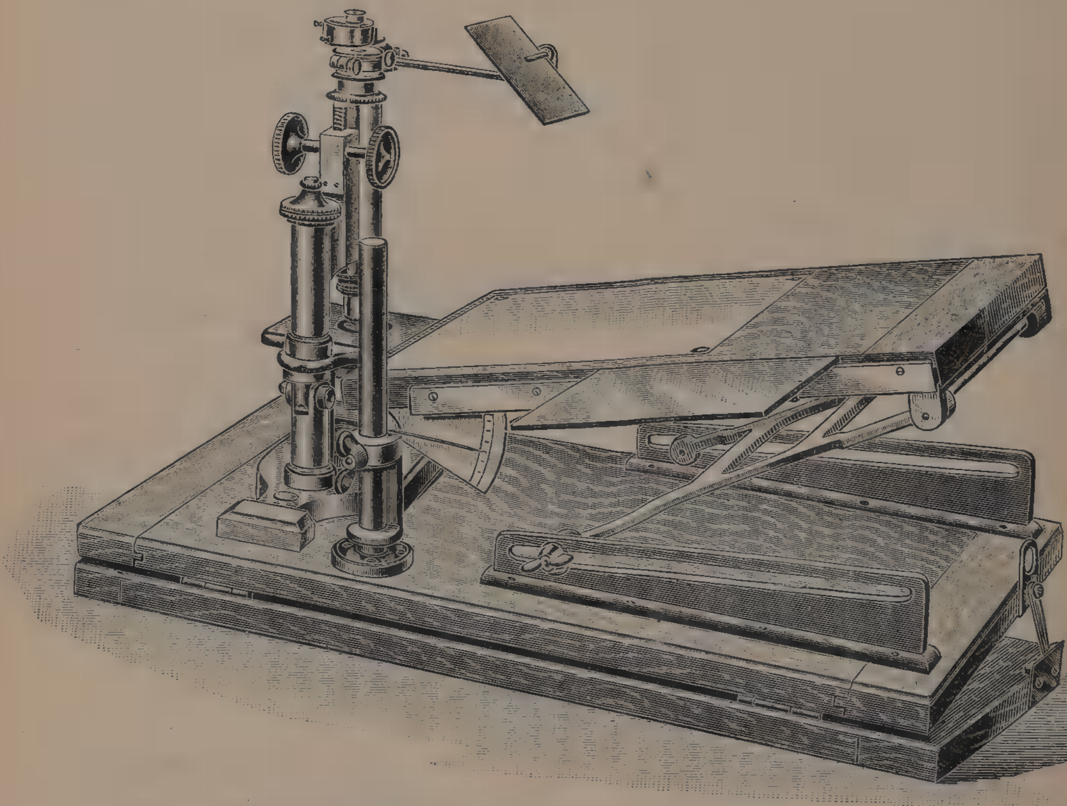

FIG. 279.—Adjustable Drawing Table for Use with Camera Lucida.

may be accomplished by closing the diaphragm below the stage to a smaller aperture, or by letting more light fall on the paper by means of raising curtains or setting up the apparatus nearer to a window. If the pencil appears plainer than the object, the paper should be shaded by setting up a screen of cardboard or some other material. The camera lucida illustrated in figure 278 is provided with means for regulating the light from both sources. By means of the knobs K a series of smoked glasses of different intensities of color is made to revolve between the prism and the mirror and between the prism and the objective, so that the light from both sources may be easily moderated as desired.

If the magnified image covers much space, the paper should be inclined by raising the right-hand end of the support on which the paper lies until the outline of the field of view drawn on the paper appears circular, assuming that the camera lucida has been so centered that the field, as seen through the microscope, appears circular. If this adjustment is not attended to, the image projected on the paper will be more or less distorted according to its size.

The camera lucida may be used to determine the magnifying power of the microscope and to measure the actual diameter of objects, as already described in connection with the two-eye method of projection.

In drawing outlines with the camera lucida the lines should be made with a very light pressure of the pencil, and then evened up and made heavier afterward.

The adjustable drawing table shown in figure 279 is so constructed that the height of the table may be varied, the table, together with the microscope, may be inclined, and the drawing board may be inclined at the angle necessary to prevent distortion of the image.

THE MICROTOME.

While substances in the form of powder may be prepared for examination in the manner suggested for starch, most plant tissues must be cut into very thin sections before their structure can be clearly made out with the compound microscope. The microtome facilitates the process of section cutting, and gives results much better than can be obtained with free-hand section cutting.

A simple and very effective form of microtome for all purposes is shown in figure 280. This microtome consists of a solid iron frame, which can be clamped to the laboratory table by means of the clamp-screw C. Two glass plates, PP, are fastened to the top of the frame to form a guide for the section-knife. The screw S operates the clamp which holds the object rigidly in position for cutting. The micrometer-screw M raises and lowers the object-holder. The milled head of the micrometer-screw is graduated into 100 parts, and the micrometer-screw has a pitch of 0.5 millimeter, so that sections as thin as 0.005 millimeter may be accurately gauged.

An ordinary razor may be used as a section knife with this microtome, but a razor with longer blade specially designed for the purpose is to be preferred. Section-razors are made with one side ground flat, but a double-concave blade is to be preferred because it is much more easily kept sharp, and is otherwise quite as efficient as the plano-concave form.

In cutting sections the razor should be held firmly, edge and back,

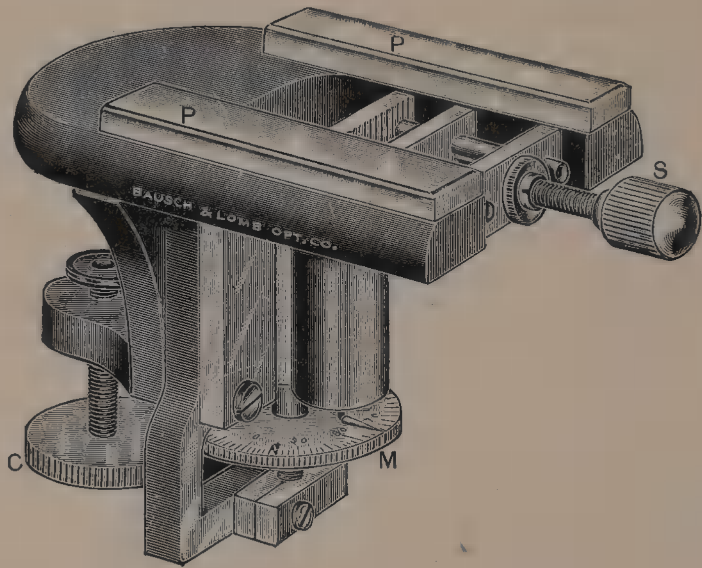

FIG. 280.—Simple Microtome. Description in text.

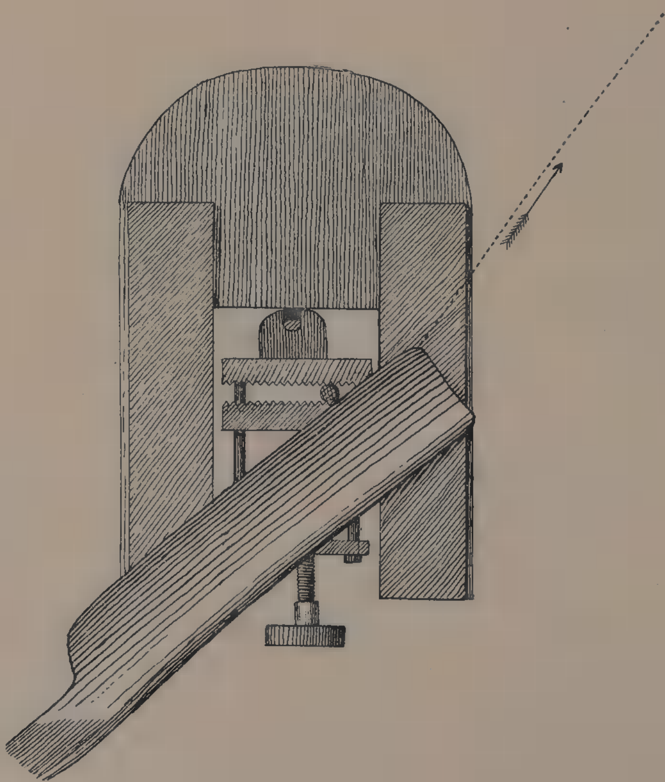

FIG. 281.—Position of Razor in Cutting Sections with Simple Microtome. Description in text.

against the glass guides, and with the toe or front end inclined forward (Fig. 281), and as close to the inner edge of its guide plate as possible; the cutting motion should then be a forward one against the object, and at the same time a sliding motion should be imparted to the razor from the heel toward the toe, as indicated by the arrow. The forward and lateral motions should be so correlated as to bring the full length of the razor into use.

Methods of imbedding objects for sectioning will be given in succeeding pages (pages 526, 529, 534).

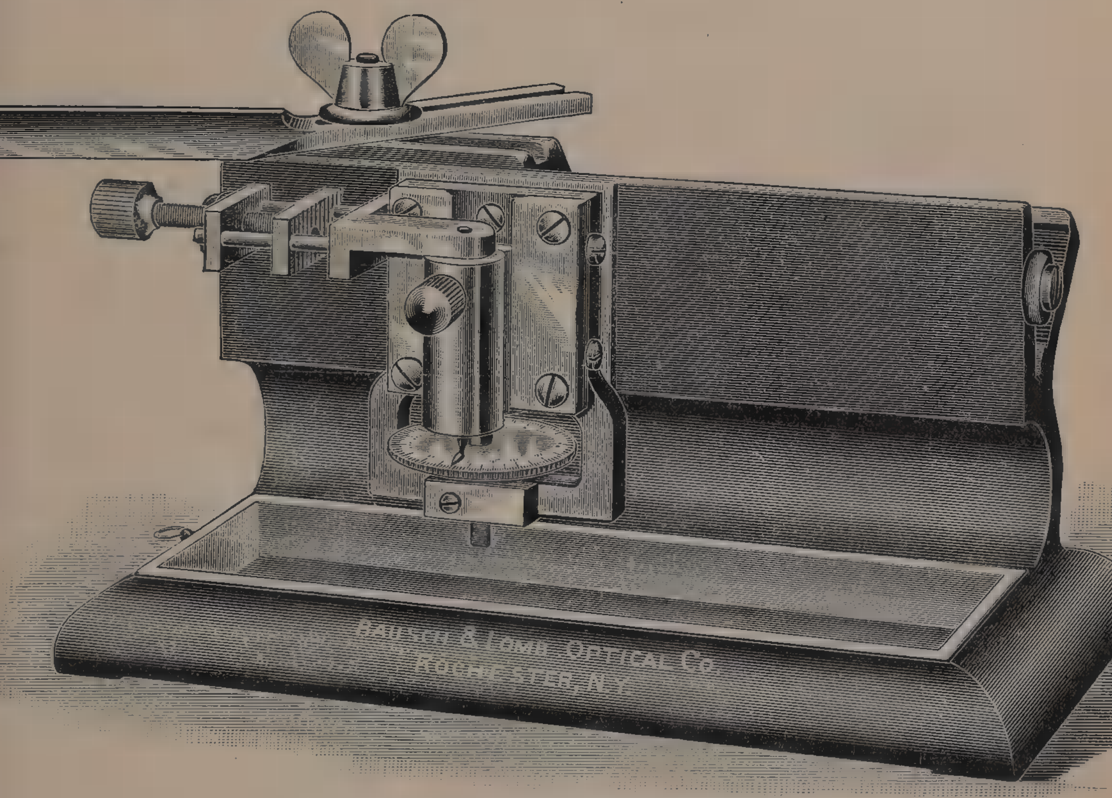

Fig. 282.—Microtome with Sliding Knife Carrier.

Another and more elaborate form of microtome is shown in figure 282. Here the section-knife is carried on a solid iron block which slides in a V-shaped bed. By means of a thumb-screw the knife can be set at any desired angle. The object-holder and the micrometer-feed are essentially the same as in the simpler microtome of figure 280.

Other forms of microtomes will be found described in the catalogues of Bausch & Lomb, Rochester, N. Y.; E. Zimmermann, Leipzig; R. Jung, Heidelberg; and C. Reichert, Vienna.

Sharpening the Microtome Knives.—To insure good work the edge

of the section-cutter should be kept in the very best condition. This is an absolute necessity to success in section-cutting.

There is nothing better for sharpening a razor than the Torrey combination strop and hone.

To test the edge of a razor or other section-cutter moisten the end of the thumb and draw it with very light pressure over the cutting-edge. If the edge, throughout its entire length, gives the sensation of taking hold of the skin, the use of the hone will not be necessary, and only the strop should be used; but if the edge at any place slide over the skin without

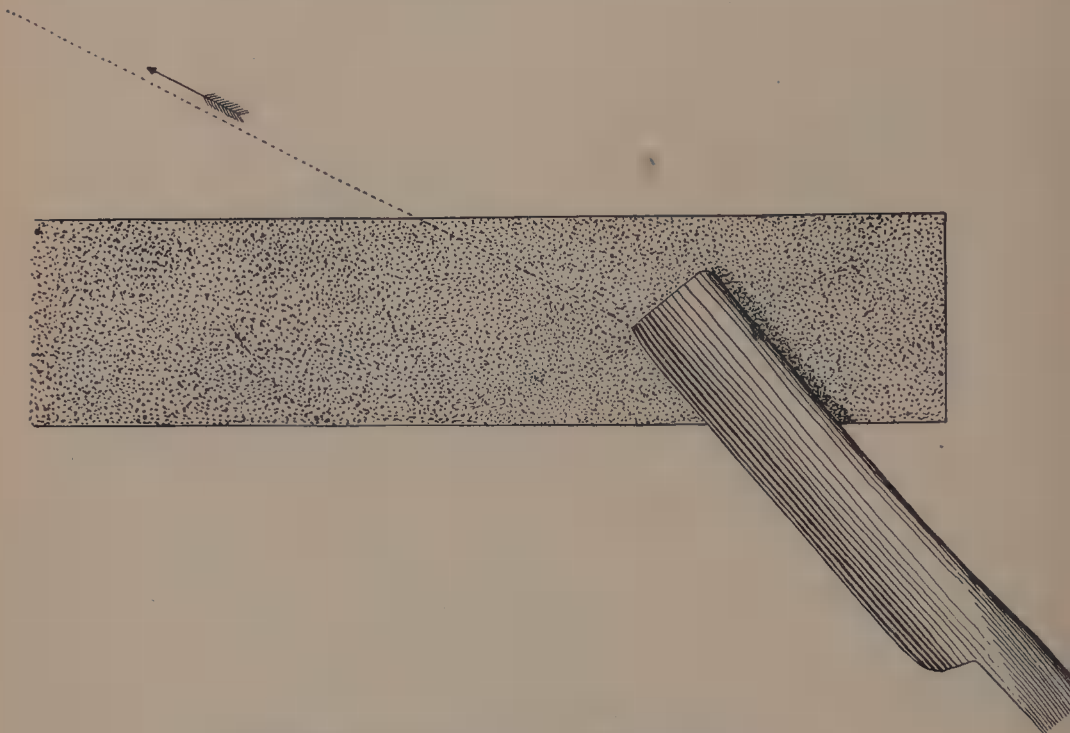

FIG. 283.—Method of Honing Razor or Microtome Knife on the Stone.

taking hold, the hone must be used until the edge responds properly to the test.

To use the hone, put a drop or two of thin mineral oil on its surface, or lather it with soap; the lather is rather better than the oil for keeping the pores of the stone open. Now draw the razor over the stone, edge foremost, passing obliquely from toe to heel, as shown in figure 283, turning the razor and honing the other side of the blade on the back stroke. The blade should always be held flat, edge and back, upon the stone, and only a very slight pressure should be exerted. After honing, the blade should be wiped off on a soft cloth in such a way that the cutting-edge does not come in contact with the cloth. Then strop the razor on

leathers 1, 2, and 3, passing obliquely from heel to toe, as shown in figure 284, stropping the other side of the blade in like manner on the back stroke.

When the edge is in proper condition, it should, throughout its entire length, easily clip a hair held between the thumb and forefinger.

If a microtome knife, such as is used on the microtome shown in figure

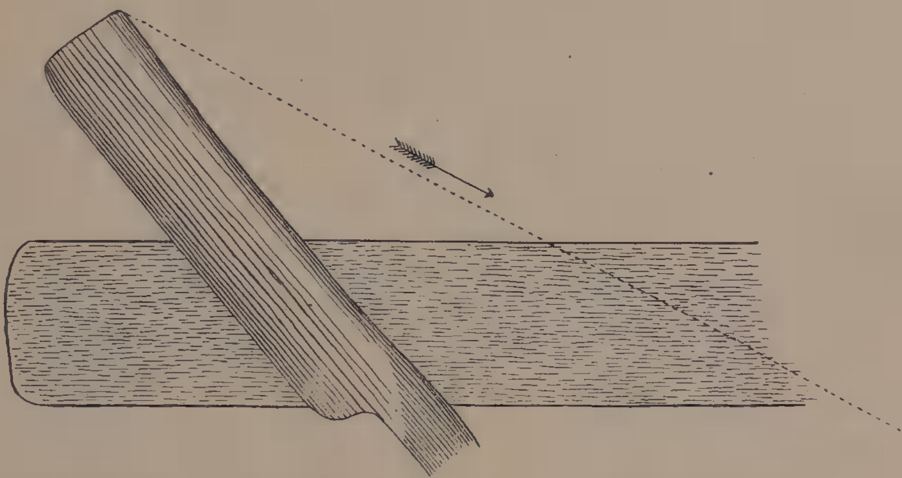

FIG. 284.—Method of Stropping Razor or Microtome Knife on the Prepared Leather Strop.

FIG. 285.—Steel Back to be Adjusted on Back of Microtome Knife Preparatory to Sharpening.

282, is to be sharpened, it should be treated in exactly the same manner as described for the razor, excepting that a steel back, shown in figure 285, should be adjusted on the back of the knife; this allows the knife to lie on the stone and strop at the proper angle, and a keen edge is much more easily obtained by its use.

The removable back should be adjusted, by the makers, to the particular knife with which it is to be used.

CHAPTER II.—PREPARATION OF MATERIAL FOR SECTION-CUTTING.—DIFFERENT METHODS OF SECTION-CUTTING.

Sections in three different planes are usually necessary in order to get a clear understanding of the structure of a plant member; these are (1) a cross-section, which is a section transverse to the long axis of the member;

(2) a longitudinal radial section, which is parallel to the long axis of the member and passes through its center; and (3) a longitudinal tangential section, which is parallel to the long axis of the member and perpendicular to the radial section (see Fig. 286).

Fresh plant material may often be sectioned to advantage free hand—that is, the material to be sectioned may be held between the thumb and forefinger of one hand while the razor is wielded by the other. The razor should be kept flooded with water or 50 per cent. alcohol, so that the sections may slip smoothly over the razor while being cut. The blade of the razor should rest upon the forefinger of the hand which holds the specimen, so that the forefinger may serve as a guide in determining the thickness of the sections. The cutting should be begun at the toe of the razor and should progress toward the heel, the stroke being a long, sliding one. The material frequently needs to be held in a support while being sectioned; this would be the case, for instance, with leaves or tender stems and roots. Elder pith is an excellent imbedding medium for delicate

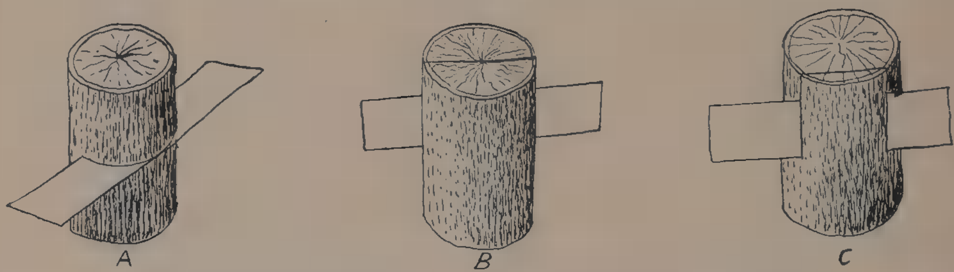

Fig. 286.—*A*. Position of Knife in Cutting Cross-sections. *B*. Position of Knife in Cutting Longitudinal Radial Sections. *C*. Position of Knife in Cutting Longitudinal Tangential Sections.

tissues; cork which is free from grit will answer for harder tissues, while some soft wood, such as the Linden, will be needed for imbedding objects which are small and quite hard, such as some seeds.

In general, however, a microtome is to be preferred, even in cutting fresh material. Whether the form of the microtome be that figured in figure 280 or 282, the razor or knife should make a long, sliding cut.

If elder pith is to be used for imbedding, it should be cut in two, longitudinally, through the middle; to do this without danger of breaking the pith, lay the pith upon the table and hold it firmly between the thumb and forefinger while halving it with a sliding cut of a scalpel or pocket-knife.

If the object to be sectioned is fairly thick, grooves may be cut in the elder pith to receive it, but the grooves should not be so large as the object. If the object to be sectioned is small, and extends only a short distance down the length of the pith, a piece of pith or cork should be placed between the lower ends of the pieces of pith, so that when these are clamped

together between the jaws of the object-holder of the microtome, their inner faces will stand parallel to each other, and so exert a stronger grip on the object than if they slanted together toward the lower ends.

After the pieces of pith holding the object have been clamped in position on the microtome, their upper ends may be trimmed away somewhat, as shown in figure 287.

If cork is used for imbedding the object, all gritty dark brown spots should be avoided, since these are pretty certain to nick or turn the edge of the section-cutter.

Rigid bodies, such as woody stems, will not need imbedding, provided they are large enough to be clamped in the microtome. Woody tissues which have become dry are best prepared for sectioning by allowing them to soak in water for a time, and then transferring them to equal parts of 70 per cent. alcohol and glycerine. Dry seeds and fruits may be confined in hot steam for half an-hour. Small air-dried seeds may be melted into a block of hard paraffin. Brittle objects which easily break in pieces on cutting may be prepared for cutting by spreading a thin film of 2 per cent. collodion over the surface of the object with a camel's-hair brush shortly before cutting each section. The tendency of sections from woody tissues to become ragged in cutting may be obviated by impregnating them with a glycerine-gum prepared by dissolving 10 Gm. of gum arabic in 10 Gm. of water, and adding 40 to 50 drops of glycerine and a trace of carbolic acid to keep from spoiling. The material should first be soaked in water, and then transferred to the gum mixture diluted with twice its bulk of water. The object is cut into as small pieces as possible before being placed in the gum solution. The solution is left exposed to the open air until it attains the consistency of syrup; the object is then removed and placed on a glass plate to further harden. On the following day the hardened crust of gum is removed from the side of the object where the sections are to be cut, and in about two days thereafter the sections may be cut. The gum may be removed from the sections by warm water.

FIG. 287.—Object Imbedded in Elder Pith Preparatory to Cross-sectioning.

When the protoplast and the processes of cell division are to be studied (see p. 552), the fresh material must be put through processes of fixing and hardening which will as nearly as possible coagulate the protoplast in its natural form, so that during subsequent manipulations of imbedding, sectioning, etc., the organs of the protoplast will retain their finer details of structure. These processes will now be given in the order in which they must be employed.

Fixing the Fresh Material.—The process of fixing involves the killing and apparent coagulation of the protoplast in the form which it possessed during life, even to the finest details of its structure.

The fixative which gives uniformly the best results is known as Flemming's fixative. This is made as follows:

One per cent. chromic acid,	16 parts
Two per cent. osmic acid,	3 parts
Glacial acetic acid,	1 part.

The 1 per cent. chromic acid is made by dissolving 1 Gm. of chromic acid crystals in 99 Cc. of distilled water, the 2 per cent. osmic acid by dissolving 1 Gm. of osmic acid crystals in 49 Cc. of distilled water, and the glacial acetic acid is used just as it comes from the chemist's. The preparation of the chromic acid solution requires no particular precaution, but the osmic acid solution must be made with extreme care in excluding all traces of organic materials, else the solution will spoil in a short time, as shown by a black precipitate. The bottle in which the solution is to be made and kept should have a glass stopper, and should be thoroughly washed out, and then concentrated sulphuric acid saturated with potassium bichromate should be poured into the bottle and shaken up until all parts have been washed by it; the stopper should also be washed in the same manner as the bottle. The sulphuric acid should then be poured out, and the bottle and stopper rinsed several times with distilled water. The crystals of osmic acid are obtained from the manufacturers sealed in glass tubes; one of these tubes containing a gram of the osmic acid is washed and rinsed in the same manner as the bottle, and is transferred to the bottle without being touched by the hands or anything likely to leave organic substances on it, however slight the amount. A clean glass rod will serve to guide the tube from the dish in which it has been rinsed into the bottle. About 10 Cc. of distilled water should now be poured into the bottle. Then the bottle should be tightly stoppered and violently struck against the palm of the hand until the tube containing the osmic acid is broken. Then the remaining 39 Cc. of distilled water necessary to make the 2 per cent. solution of osmic acid should be poured into the bottle. The bottle should always be tightly stoppered and kept in a safe place. It must be remembered of the osmic acid that it is very volatile, poisonous, very corrosive to the mucous membranes, and so should not be inhaled or the vapors of it allowed to enter the eyes; and it is certain to be spoiled if organic substances get access to it. The distilled water used in its preparation should therefore be caught in a receptacle free from organic matter.

In order to insure the best results the fixative should be able to pene-

trate quickly to all parts of the material to be fixed; therefore the material should be cut into the smallest pieces compatible with the purposes of the study. Pieces of leaves need not be more than 5 mm. long and 2 mm. broad; root-tips need not be longer than 2 or 3 mm.; pieces of stems, roots, etc., should be cut only a few millimeters long and then quartered or cut into smaller pieces longitudinally according to their size; small ovaries should be opened at two ends, and larger ones should be cut into pieces; or, if the ovules are alone to be studied, they may be put into the fixative singly if they are large, or if they are small, the placenta bearing a line of ovules may be cut out and put into the fixative. These suggestions will serve to emphasize the fact that the material to be fixed must be cut into as small pieces as possible.

The amount of fixative used should be large in proportion to the amount of material to be fixed; for instance, fixative to the height of 3 Cm. should be put into a 1½-dram short-style homœopathic phial to fix about ten small pieces of root, tips, leaves, etc.

The material should be left in the fixative for about forty-eight hours, and should then be washed in running water for six hours.

Hardening the Fixed Material.—After the fixative has been thoroughly washed out, the material should be transferred to 20 per cent. alcohol, and thence at intervals of two hours to successive alcohols each 10 per cent. stronger than the last, until the absolute alcohol is reached; this hardens and dehydrates the material so gradually that a collapsing of the protoplasts is avoided. If the material is not to be imbedded and sectioned at once, it may be left in the 70 per cent. alcohol until wanted, and then it may be transferred to the higher alcohols as if the succession had not been interrupted.

Imbedding in Paraffin.—Material which has been fixed as above, and has gone as far as the 70 per cent. alcohol, may be taken from this, imbedded in elder pith, and sectioned free hand or in a microtome, as already directed for fresh material; but with delicate tissues by far the better results are obtained by imbedding in paraffin and sectioning with a microtome.

To imbed in paraffin the material is taken from the absolute alcohol, where it has become thoroughly dehydrated, and placed in equal parts of absolute alcohol and chloroform; then at intervals of two hours the material is successively transferred to a bottle of pure chloroform, then to a second bottle of pure chloroform, then to pure chloroform to which bits of paraffin are gradually added until the chloroform is saturated at the temperature of the room. Then the saturated chloroform containing the material is placed on the paraffin oven or other place which is warm but still below the melting point of the pure paraffin, which should be about 52° C.,

and the chloroform gradually saturated at this higher temperature. Then the saturated chloroform with the material should be poured out into a watch-glass or other shallow dish, and should be placed in the paraffin oven at the temperature at which the pure paraffin would melt (52° C.) and left there, uncovered, until the chloroform has entirely evaporated, which will be the case when the paraffin no longer has a sweetish taste. Then the paraffin with the material is poured out into a shallow paper tray which is standing on something cool, such as a porcelain slab, and the pieces of material are arranged in rows with dissecting needles, which are heated in the flame of an alcohol lamp or Bunsen burner as often as is necessary to melt away the film of hardening paraffin at the surface. The pieces should be so separated from each other that they may finally be cut out singly with a good border of paraffin all around. When the material is all arranged, the surface of the paraffin should be blown upon until a film is formed, and then the tray should be carefully submerged in a dish of cold water; if ice-water, all the better. In pouring the melted paraffin into the paper tray the dish of melted paraffin should be held so close to the tray that spattering of the paraffin and consequent entanglement of air-bubbles is avoided. The tray should stand on something cold, as already suggested, in order that the material may not settle entirely to the bottom of the tray but may be arrested by a layer of hardened paraffin which has quickly formed there; otherwise there would not be a layer of paraffin of sufficient thickness bounding the material on the lower side. The tray is submerged in cold water as soon as possible, for the reason that if the paraffin is allowed to harden slowly, is has a loose crystalline texture and does not hold together well about the sections when these are being cut on the microtome.

Sectioning Material Imbedded in Paraffin.—After the paraffin in which the material is imbedded has hardened in the cold water, the paper tray may easily be stripped off. To prepare the imbedded material for sectioning on the microtome cut out a block of paraffin containing the specimen which is to be sectioned; the block should be large enough to leave a thickness of about 2 mm. of paraffin on all sides beyond the specimen. Coat a pine stick about 3 cm. long and 1 cm. square on one end with melted paraffin; then warm the coat of paraffin on the stick to the point of melting, and quickly press the block of paraffin containing the specimen into this melted paraffin in such a position that when the stick is fastened upright in the microtome, the knife, running in a plane at right angles to the long axis of the stick, shall cut the specimen in the desired direction. Now heat a dissecting needle in the flame of an alcohol lamp or Bunsen burner and melt the edges of the paraffin block slightly all around at the base so that the paraffin block is well sealed to the stick.

The paraffin block may then be well hardened by dipping into cold water. Trim down the paraffin block with a sharp knife so that at least two opposing faces are parallel, and so that the specimen will be surrounded on all sides with a thickness of paraffin of about 1 mm. Fasten the stick upright in the object-holder of the microtome, and adjust the stick and holder to such a height that the knife will be able to cut the paraffin soon after the micrometer feed-screw has begun to be operated. The micrometer feed-screw should have been run down to near its lowest point before fastening the stick in the object-holder, so that the specimen may not need readjustment after the sectioning has begun.

If the simple form of microtome shown in figure 280 is used, the razor should be held firmly, edge and back, on the glass knife-guides, and parallel with the front face of the paraffin block and only about 5 mm. distant from it. Then the section should be cut with a quick, direct forward movement, and the stroke should be arrested before passing far beyond the block. The razor should be held between the thumb and forefinger of both hands, and the hands should rest against, and be steadied by, the lateral edges of the top of the microtome. The forward motion of the razor should be accomplished by the movement of the thumb and forefingers and of the wrists.

Just before each forward movement of the razor the micrometer feed-screw should be turned the desired distance; 10 micromillimeters is a good average thickness for the sections. Sections seldom need to be cut less than 5 micromillimeters. (A micromillimeter = $\frac{1}{1000}$ of a mm.)

The razor should be so held at each forward stroke that the section last cut, which has been left in its original position on the razor, will stand immediately in front of the paraffin block; in this way the sections may be made to hold together in ribbons, and they can subsequently be handled with much greater expedition than if they are removed separately from the razor.

Success in cutting thin sections from paraffin depends on a proper temperature of the room; this, for paraffin melting at 52° C., should be between 21° and 24° C., or 70° and 75° F. If the temperature is too high, the sections will crumple up in cutting, or if too low, the paraffin will be brittle, and the sections are apt to crumble.

If the microtome shown in figure 282 is used, the stick holding the block of paraffin is fastened in the object-holder as described above, the micrometer-screw being run far down so as to permit of a feed through a long distance without the necessity of readjusting the block. The section-knife should be set parallel with the opposing face of the paraffin block, and in all cases the front and back faces of the paraffin block should be parallel with each other. In operating the knife the elbow should

rest on the table and the knife should be drawn back and forth with a wrist movement. The stroke of the knife should be a very short one, and the micrometer-screw should be turned upward the desired distance just after the backward stroke of the knife and before the forward stroke has begun. It sometimes happens that the pitch of the knife from edge to back needs adjusting; when no special mechanism is provided for this purpose, it may be accomplished by placing a piece of paper or thin cardboard under the front edge or back edge of the knife where it is clamped to the knife carrier.

It sometimes happens that the sections crumble up on cutting even when the temperature is right. This is usually due to an imperfect impregnation of the specimen by the paraffin. If the impregnation is complete, the cut surface of the paraffin block through the specimen will look smooth and shining.

Some plant tissues are especially hard to imbed on account of the large amount of air which fills their intercellular spaces; this is particularly true of leaves. It is therefore a good plan, before fixing the material in the Flemming's fixative, to put it into 0.5 per cent. chromic acid and then to pump the air from this; as soon as the atmospheric pressure is again turned on, the chromic acid will be forced into the intercellular spaces which were formerly filled with air. The removal of the air from the specimen is in the interest of the fixing as well as of the imbedding of the material.

Mounting the Sections on the Slide.—Assuming that the sections have adhered in the form of a ribbon while being sectioned, the ribbons should be laid in a place free from dust, with the side downward which was next to the knife as the sections were cut; it will be noticed that this side is glossier than the other, and when mounted on the glass slide, will make a smoother contact than the other side.

Clean one surface of a slide which has been kept for some time submerged in a saturated solution of potassium bichromate in concentrated sulphuric acid very thoroughly by rinsing in water and rubbing it vigorously with a clean cloth stretched over the forefinger; this process should be repeated until a film of water may be made to lie evenly over the surface of the glass. If the water shows a tendency to creep away from any portions of the glass, those portions are not sufficiently clean. When the slide is clean, place several drops of albumin-water on the slide, and with a dissecting needle or glass rod draw them out until they form an even layer over the surface to be occupied by the sections. Cut the ribbons into pieces of the desired length, remembering that the paraffin will stretch on being warmed subsequently, and transfer the pieces to the surface of the albumin-water on the slide, placing the under, glossy side

downward. If it is desired to study the sections in the same order in which they were cut, the pieces must be placed on the slide in rows which form a continuous series. It is best to put the rows close together, and, if desired, they may be made to cover the entire breadth of the slide. With a piece of filter paper draw away a part of the albumin-water from under the sections, especially if there is enough of the water on the slide to cause the sections to float about, and at the same time push the sections into even rows with the filter paper. Then lay the slide, with a piece of blotting paper beneath it, on top of the paraffin oven, so that it will not be heated sufficiently to melt the sections, and leave on the oven several hours to dry. The sections will not adhere so firmly to the slide if allowed to dry at a low temperature.

The albumin-water above referred to is made as follows: Shake together equal parts of white of egg and distilled water and add a pinch of salicylate of soda to keep from spoiling; this is a stock solution, one drop of which is added to each ounce of distilled water to form the albumin-water. The albumin-water causes the sections to adhere firmly to the slide, but the very weak solution of albumin does not leave a sufficiently thick layer on the slide to hold the stain when the sections are being stained.

When the sections have dried to the slide, it should be immersed in a dish of xylol to a depth sufficient to cover the sections. Here it should remain until the paraffin has been entirely dissolved. It should then be transferred to a dish of absolute alcohol to wash off the xylol and so be fitted for transference to an aqueous stain. Absolute alcohol should always be the intermediary between xylol and water, whether progressing from xylol to water or from water to xylol, otherwise a milky turbidity will be formed on the slide which is difficult of elimination.

Staining the Sections.—After the xylol has been thoroughly washed out in the alcohol, the slide may be transferred to a dish containing the desired stain. For methods of manipulation, see chapter on Reagents.

A beautiful differentiation in shades of gray may be obtained by the use of iron hæmatoxylin described in the chapter on Reagents. Other stains are given in the same chapter.

Sealing in Balsam.—Slides which have been stained and dehydrated in 95 per cent. alcohol may then be placed in xylol, preparatory to sealing in Canada balsam according to the following directions: Remove the slide from the xylol and place it quickly on a piece of filter paper, so that the side holding the sections lies upward; then put a small drop of Canada balsam on the slide near to the right end of the space covered by the sections; place a cover-glass, which has been cleaned and then dipped into xylol and again wiped off, on the slide while holding it by opposing edges between the thumb and middle finger, the right edge of the cover-glass

being first placed in contact with the glass and the middle finger placed against it, while the left edge is being slowly lowered by means of a dissecting needle; as the cover-glass comes in contact with the drop of balsam, and is spreading it out toward the left, care should be taken that no bubbles of air become entangled with the balsam; danger of this becomes lessened, and the small drop of balsam is made more surely to cover the entire space under the cover-glass if the forefinger is made to press upon the cover-glass, beginning at the right edge and passing toward the left as the cover-glass is being lowered, the cover-glass being then held by the thumb and middle finger in order that the forefinger may be free to perform this office.

Experience will teach the size of the drop of balsam necessary for a given size of cover-glass. The drop should be no larger than is necessary to cement the cover-glass to the slide with a very thin layer.

After the cover-glass has been put on, the slide should be placed in a warm situation for hardening the balsam; the top of the paraffin oven or an incubator with a temperature of about 50° C. will furnish the proper conditions for this. The slides should be kept at this temperature for about a week, or even longer, when any balsam which may have pressed beyond the cover-glass may be scraped off and the slide cleaned up with a cloth moistened with xylol. If the balsam is not dried at a somewhat high temperature, as suggested, even after the expiration of several months the balsam will be soft enough for the cover-glass to be easily displaced, particularly on warm days.

Imbedding in Collodion.—For most purposes paraffin is to be preferred above any other substance for imbedding; its use facilitates the process of section-cutting and the subsequent mounting of the sections on the slides more than any other substance. For some purposes, however, collodion has been found very useful. When it is desired to cut sections from large pieces of material, such as whole fruits, or of old tissues which have been found not to give good results in paraffin, collodion may be found to answer the purpose.

Material to be imbedded in collodion is prepared in the same manner as for paraffin-imbedding, until the 95 per cent. alcohol is reached in the process of dehydrating and hardening. From the 95 per cent. alcohol the material is transferred to equal parts of 95 per cent. alcohol and ether; here it remains for two hours, or longer if the material is in large pieces, though this should always be in as small pieces as possible. The material is next transferred to a 2 per cent. solution of collodion in equal parts of 95 per cent. alcohol and ether, and allowed to remain for from twelve to twenty-four hours or longer as experience may prove necessary for the specific material. The cork is now to be removed from the bottle so that the collodion may slowly become more concentrated by the evap-

oration of the solvent. When the solution is still capable of pouring, but quite concentrated, it is run out into the paper trays, made from ordinary writing-paper; here the material is distributed with needles equally in rows, and after a skin has formed on the surface of the collodion, the tray is immersed in chloroform, where the collodion hardens in a few hours to the proper consistency for sectioning. The material should then be kept in 80 per cent. alcohol until needed for sectioning.

When it is desired to cut sections from this material, a small block of collodion containing the specimen is cut out from the tray and fastened on a pine stick, as described for paraffin, by spreading some 5 per cent. collodion kept for this purpose over one end of the stick, and placing the block of collodion on this in such a way that the sections may be cut in the desired direction when the stick is held upright in the object-holder of the microtome. Then more of the thick collodion should be painted all around the base of the block so as to make the union with the stick more secure, and after this has stiffened somewhat in the atmosphere, the block, with the stick cemented to it, is put into chloroform to harden, and then placed until needed in 80 per cent. alcohol.

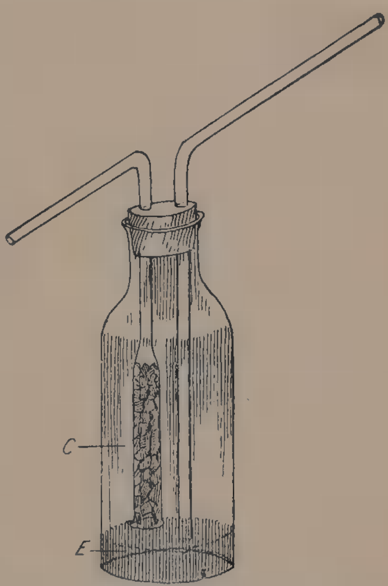

Fig. 288.—Bottle for Blowing Vapor of Ether over Collodion Sections for Fixing Them to the Slide. The long tube dips below the surface of the ether, but the calcium chloride dryer does not. *E.* Ether. *C.* Tube containing calcium chloride for drying the ether vapor.—(*After Thomas.*)

When sectioning material imbedded in collodion, the razor or knife should be held quite oblique to the line of motion, in order that a long, sliding stroke may be made, and the razor or knife should be kept flooded with 80 per cent. alcohol.

The sections may be removed from the razor or knife as soon as cut and transferred to a slide which is kept wet with 80 per cent. alcohol. After the desired number of sections has been arranged on the slide, the alcohol should be filtered away and the slide allowed to dry. Before the sections begin to crinkle, however, vapor of ether should be blown over the slide from a bottle provided with a calcium chloride dryer, as shown in figure 288. The sections may now be stained, washed quickly in water, dehydrated in 95 per cent. alcohol, transferred to xylol, and then sealed in Canada balsam, as already described for paraffin sections.

Making Permanent Mounts in Glycerine Jelly.—Directions for making glycerine jelly are given in the chapter on Reagents, etc. Glycerine

jelly is an excellent mounting medium for sections from fresh material, or for sections from material which has been imbedded in collodion. Sections from fresh material are stained by lying for some hours in a dilute solution of the desired stain; the surplus stain is then removed, as directed under the specific stain employed, and after the sections have been transferred to a watch-glass containing 2 parts of water and 1 part of glycerine, the water is allowed to evaporate from the glycerine in a place free from dust. A small piece of glycerine jelly is then placed on a slide, and the slide warmed until the jelly melts; then while the slide is still kept warm the section is removed from the glycerine and placed in the melted jelly on the slide, and a clean and warm cover-glass placed over the specimen in the manner already recommended for balsam mounts. Then the slide is put away for the jelly to harden. After some months, when the glycerine jelly has thoroughly set, a ring of shellac or Brunswick black may be run around the cover-glass for additional protection.

Sections which have been imbedded in collodion may be mounted in glycerine jelly in the same manner as fresh material, without any attempt to remove the collodion from the sections, since the collodion becomes perfectly transparent in the jelly.

Permanent Mounts from Material Imbedded in Elder Pith, etc. —Fresh material, or material which has been fixed and hardened as far as the 70 per cent. alcohol, may be imbedded in elder pith, etc., for sectioning, and the sections may be floated off into watch-glasses containing the desired stains, from which the sections may be mounted in glycerine jelly as above, or they may be dehydrated in 95 per cent. alcohol and absolute alcohol, passed into xylol, and then mounted in Canada balsam.

Material which has been fixed in a fixative containing osmic acid is apt to be more or less blackened by the acid. Before such material is transferred to the stains it should be placed in a bleaching solution made by mixing 1 part of hydrogen peroxide with 15 parts of 70 per cent. alcohol; the bleaching process should be completed in about twenty minutes.

The transference of separate sections into different reagents, and finally to the slide, is readily accomplished by means of a section-lifter improvised by grasping a thin disk of elder pith with a pair of forceps and clamping the forceps by means of a rubber band.

CHAPTER III.—THE PLANT CELL AND ITS PRODUCTS.

Plants are not homogeneous bodies, but are built up of minute structural elements known as cells. Some plants, indeed, consist of a single one of these structural units, and are then unicellular, such as yeasts, and pleurococcus, which forms the mealy, green growth over the bark on the north side of trees; but as a rule most plants which grow to more than a microscopic size are built up of many cells. Even the minute cells are not homogeneous, but are differentiated into certain distinct structures which have definite functions to perform in the vital activities of the plant.

Longitudinal sections through the root-tip of an onion furnish excellent material for the study of a typical cell. Figure 289 shows cells of various ages from the onion root-tip. At A are very young cells. The outer wall, *W*, is of cellulose; within this is the protoplasmic body which fills the entire cell. The life of the cell resides in this body, and all of the vital phenomena have their origin there. It will be seen that the protoplasmic body is differentiated into distinct parts. Immediately applied to the cell-wall is a lining membrane of protoplasm, which is a somewhat differentiated outer layer of the protoplasmic body. Within the protoplasmic body is the nucleus, *N*, containing the nuclei, *NL*, and at intervals are small well-defined bodies, *L*, known as the leucoplastids. That portion of the protoplasmic body exclusive of the lining membrane and the nucleus and leucoplastids is known as the cytoplasm. The lining membrane, the nucleus with its nucleolus, the plastids, and the cytoplasm, taken together, constitute the protoplast, or energid. The parts of the protoplast just enumerated have distinct functions to perform, and so may be considered as organs of the protoplast. In the very young cells, A, the protoplast fills the entire cavity inclosed by the wall; but as the cell becomes older, the growth of the protoplast does not keep pace with that of the cell-wall; and, since the lining membrane adheres always to the cell-wall, cavities, V, arise in the cytoplasm, which become filled with cell-sap, and are known as vacuoles. The vacuoles increase in size as the unequal growth of the cell-wall and protoplast proceeds, until finally the vacuoles may fuse together into one large cavity, while the cytoplasm forms a thin layer applied to the cell-wall. Through all of these changes the nucleus and the plastids remain imbedded in the cytoplasm, as shown by B and C, figure 289, and the cell-sap continues to fill the enlarging cavities. The life of the cell resides in the protoplast, and not in the cell-wall or in the cell-sap; accordingly, those cells from which

the protoplast finally disappears cease to live, as is the case with cork and pith cells, and wood and bast fibers. The cell-walls of such dead cells serve the purpose of giving protection and strength and elasticity to the plant. When a cell dies, it is not therefore necessarily lost to the economy of the plant.

The protoplasmic body, or protoplast, being the source of all vital phenomena of the plant, is the most essential part of the cell; and, indeed, nearly all other inclusions of the cell, and the cell-wall itself, are products of its activities.

The structures of the cell will now be considered in detail.

The Cytoplasm.—Under high magnification the cytoplasm appears to have a spongy structure, the meshes of which are exceedingly fine (Fig. 289,

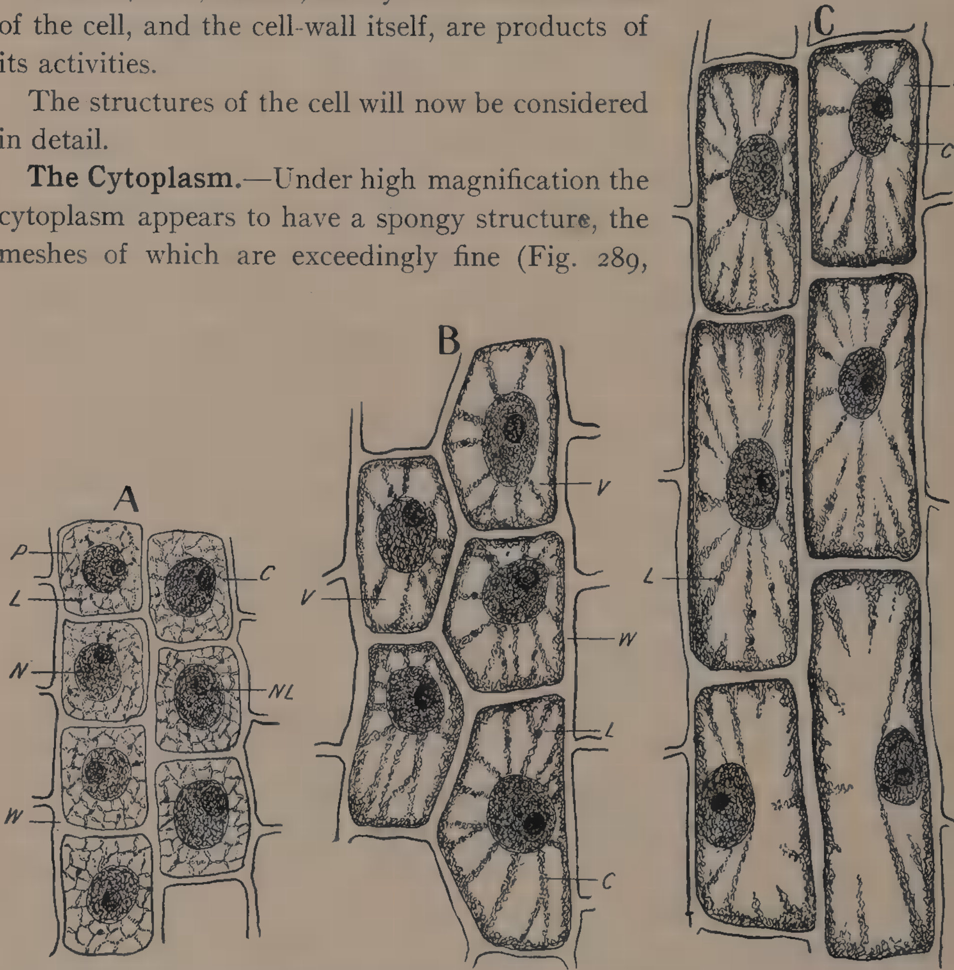

FIG. 289.—Cells from the Root-tip of Onion. A. Very young cells. *W*. Cellulose wall. *C*. Meshes of cytoplasm. *N*. Nucleus. *NL*. Nucleoli. *L*. Leucoplasts. B and C. Successively older cells where the vacuoles are becoming larger and the nucleus is coming to assume a parietal position. *V*, Vacuoles.

A, *C*). The cytoplasm is a tenacious, elastic substance of about the consistency of thin dough, although the amount of water absorbed by it may appreciably alter its consistency. It appears never to be in a fluid state, and by the use of proper fixatives it may be made to preserve its form indefinitely in material preserved in alcohol. Since

the nutritive processes of the cell are carried on in the cytoplasm, in its interstices are found various chemical compounds, such as fats, carbohydrates, various kinds of proteids, and small amounts of various ash constituents which have been brought into the cell by the water from the soil. During cell division a portion of the cytoplasm takes on a thread-like structure (Fig. 309) and becomes active in dividing the parts of the parent cell equally between the daughter cells. This thread-like portion of the cytoplasm is termed the kinoplasm, while the remaining portion of the cytoplasm seems to have a nutritive function only, and is called trophoplasm. When the cell is in the so-called resting state,—that is, when it is not undergoing division,—the cytoplasm would seem to have a nutritive function chiefly, the chemical changes taking place in it which are necessary to the nutrition of all parts of the cell. The cytoplasm of many-plant cells is seen to have the power of movement within its limiting membrane, or, in the case of the plasmodia of Myxomycetes, of changing its position as a whole, even to the extent of moving against gravity. If young, colorless stamen hairs of *Tradescantia virginica* be mounted in a drop of water under a cover-glass and examined with a $\frac{1}{6}$- or $\frac{1}{8}$-inch

FIG. 290.—Cell from Stamen Hair of *Tradescantia virginica*, highly magnified.

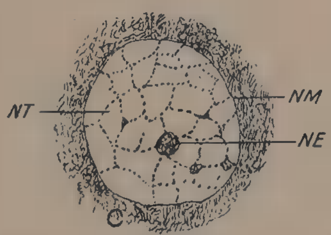

FIG. 291.—Nucleus with a Portion of the surrounding Cytoplasm. *NM*. Nuclear membrane. *NE*. Nucleolus. *NT*. Nuclear network. *C*. Cytoplasm.

objective, the cytoplasm will be seen, under favorable conditions, to be in active circulation. The arrows in figure 290 indicate the direction of flow. The movement of the cytoplasm is in this instance very complex; the strands of cytoplasm are constantly shifting their positions within the cell, and within a single strand the movement is inconstant and variable in its direction. Under the microscope the apparent rate of flow must be divided by the magnifying power to obtain the actual rate, and therefore movements which appear to be rapid are really quite slow. The whole body of the cytoplasm in the leaf-cells of *Elodea canadensis* will be found to have a rotatory motion if the leaf is severed from its stem, but kept moist in water for about an hour before the examination is made. A

small portion from the plasmodium of a Myxomycete when placed on a cover-glass, suspended in a moist chamber, and kept in the dark, will, if the conditions are favorable, spread out over the cover-glass in a layer so thin that it may readily be studied with high-power objectives without removal from the moist chamber. By this means the creeping movement of the plasmodium and the circulation of the cytoplasm within its limiting membrane may be studied in detail. The cytoplasm is seen to be capable of three kinds of movement: a circulatory movement, as in the staminal hairs of Tradescantia; a rotatory movement, as seen in the leaves of Elodia; a translocation movement, illustrated by the creeping of a part or whole of a Myxomycete plasmodium from one position to another.

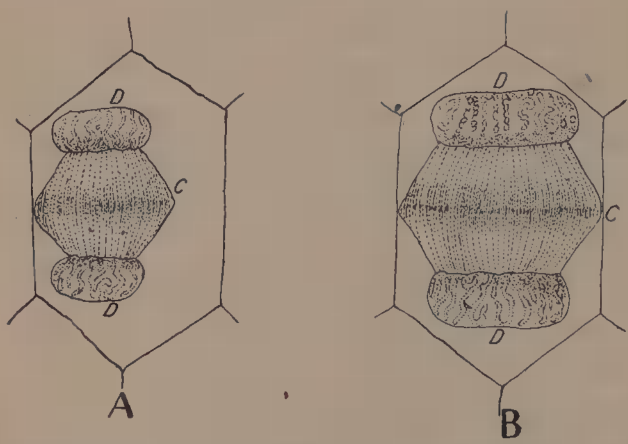

FIG. 292.—A and B represent Different Stages in Cell Division. In A, *D*, *D* are daughter nuclei which are still connected by threads of kinoplasm to the cell-plate along the equator, *C*. In B the connection of the nucleus to the cell-plate is seen to be maintained until the plate has traversed the entire cell. In later stages the plate becomes differentiated into a cell-wall, and the thread-like connection with the nuclei disappears. Since the nuclei remain connected with the plate until the latter is completed, it would appear that some formative influence is transmitted from the nucleus to the plate.

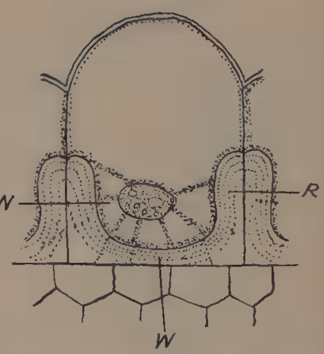

FIG. 293.—Cell from the Epidermis of the Seed Coat of *Scopolina atropoides*. The inner walls and a portion of the radial walls are becoming immensely thickened and the nucleus has taken a position near to the regions of thickening, as if the more readily to transmit the influences necessary to the localized deposition of materials. *N*. Nucleus. *R*, *W*. Thickened radial and tangential walls.—(*After Haberlandt.*)

The causes of these movements of the cytoplasm are not definitely known, but they are probably initiated by chemical changes in the cytoplasm.

The Nucleus.—The nucleus is nearly always present in every living vegetable cell. It is always suspended in the cytoplasm, whether this traverses the entire cell-cavity or has become merely a thin layer applied to the cell-walls. The nucleus in embryonic tissues is relatively very large, the diameter of the nucleus being, according to Strasburger, proportionate to that of its cell as 2 is to 3, but as growth progresses the nucleus increases in size more slowly than the rest of the cell. In young cells the nucleus is usually round, but the form of the nucleus sometimes approximates the form of its cell. When properly fixed and stained, the nucleus is seen to

be demarked from the cytoplasm by a delicate membrane which surrounds a very fine network of colorless threads within which are suspended numerous minute, colored granules, so that the thread appears to be made of alternating colorless and colored portions. Within the network are one or more nucleoli, and filling the meshes is a colorless nuclear sap (Fig. 291). The fact that stains affect nucleus and cytoplasm differently indicates in them a different chemical composition. In addition to albuminous substances the nucleus contains a substance called nuclein, which differs from the true albumins in containing phosphorus, in its indigestibility in gastric juice, by its swelling up in a 10 per cent. solution of common salt, and by its solubility in potassium hydrate.

It would be anticipated that such a well-defined and constantly present structure as the nucleus should have definite and important functions to perform. It has been demonstrated that the nucleus is the bearer of the inheritable qualities which are transmitted to successive generations of cells by the extremely exact partition of the nucleus between the daughter cells produced by cell division. This exact division of the nucleus takes place in ordinary vegetative cell-division as well as in those divisions resulting in the production of the sexual cells, which by their union give rise to new offspring. The bearing and transmission of the inheritable qualities may be considered the chief function which the nucleus has to perform, but other important functions belong to it. As the bearer of the inheritable qualities, those influences must emanate from the nucleus which stamp the cell with peculiar characteristics, and which finally give rise to that grouping of cells into the form of plant body characteristic of the species. The nucleus seems to have a direct influence on the formation of the new membranes which arise during cell division, and on the subsequent growth of the cell-walls. Figures 292 and 293 furnish evidence in support of these conclusions. There are certain metabolic processes which seem to require the presence of the nucleus, such as the formation of starch and proteids, and the production of secretions. It is certainly the rule that no cell can live long after the removal of its nucleus by any cause. The sieve tubes are an exception to this rule, but in their case it seems probable that the influence of the nuclei in the companion cells is transmitted to them. New nuclei arise only by the division of nuclei already in existence, so that all the nuclei in the phanerogamous plant body, for instance, have arisen through the division of the nucleus of the fecundated egg cell in

FIG. 294.—Nucleus Dividing by Simple Constriction; from the lining of the embryo sac of *Vicia faba*.—(*After Zimmermann.*)

the embryo sac. The division of the nucleus may take place by simple constriction, as in figure 294, or by the more complex process shown by the various stages of figure 309, which result in an exact division of the nucleus into two halves. The latter process is by far the more common, as indeed would be expected when it is considered that an exact division of the nucleus is probably a necessity to the constancy of plant forms.

The Plastids.—The plastids are organs which are entirely peculiar to plant cells. They are present in all plants excepting the Fungi. Like the nuclei, they arise only by the division of their own kind. The plastids are characterized by possessing coloring matter or the power to form it. In embryonic tissues, as in the root-tip of the onion (Fig. 289), the plastids are colorless. The colorless plastids, termed leucoplastids, may, under certain conditions of nutrition, form starch from the soluble organic materials supplied to them, and when performing this function, they are sometimes given the specific name of starch-formers, or amyloplastids. On exposure to light they may secrete the green substance chlorophyll, and are then termed chloroplastids. By means of the chlorophyll, rays of the sunlight of certain wave length are arrested within the chloroplastid, and the energy thus made available to it is used by the chloroplastid in the formation of starch from carbon dioxide and water. Under certain conditions the leucoplastids may secrete yellow and red coloring matter in the form of droplets or crystals of tabular, rod, or spindle form, and are then called chromoplastids. The chromoplastid is apt to assume the form of its crystalline inclusions (Fig. 295). The chromoplastids do not appear to have a physiological function, but they are of biological significance in that they furnish the brilliant colors by means of which insects and other animals are allured which may aid in the fecundation of the flowers or the dissemination of the seeds.

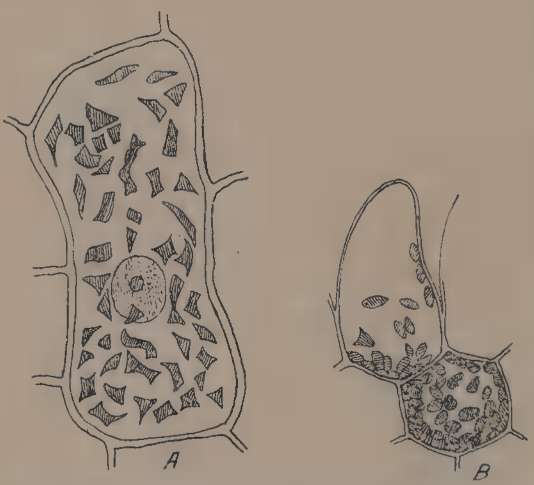

FIG. 295.—*A*. Cell from the Epidermis of the Upper Side of the Calyx of *Tropæolum majus* with Crystalline Chromoplasts. *B*. Cells from the Petal of *Lupinus luteus* with Yellow Chromoplasts.—(*A*, *after Strasburger; B*, *after Frank*.)

The Plasma Membrane.—All protoplasts, whether they are inclosed in a cell-wall or destitute of a wall, as in the swarm spores of Algæ and Fungi and in the plasmodia of Myxomycetes, are invested by a thin plasma

membrane which appears to be a differentiated outer layer of the cytoplasm, differing from the rest of the cytoplasm in being tougher and, for the most part, destitute of granules. The plasma membrane has a variety of functions to perform. It is an organ of protection in protoplasts which are destitute of cell-walls. In all cases it regulates the osmotic interchange of materials between neighboring cells and with the outer world. It is the plasma membrane which permits the water of the soil with substances in solution to pass into the plant, but prevents the fluid substances of the cell from passing out and becoming lost to the plant. While the nucleus and plastids may be shifted about by the movements of the cytoplasm, the plasma membrane remains fairly constant in its position, and is thus well adapted to receive and transmit localized stimuli; and because of this it may be considered the perceptive organ of the protoplast as well as, to a certain extent, the executive organ of the nucleus in building up or dissolving away the cell-wall. It seems very probable that the plasma membrane contributes of its own substance for the formation and growth in thickness of the cell-wall. Unlike the nucleus and the plastids, the plasma membrane can apparently be formed *de novo* from parts of the cytoplasm.

The Cell-Sap.—The cell-sap is a clear fluid with an acid reaction, containing in solution various organic and inorganic substances, such as the proteids, amides, carbohydrates, alkaloids, and acids formed within the plant, and the nitrates, phosphates, and sulphates brought into the plant by the water from the soil; it also holds oxygen and carbon dioxide gases in solution. The cell-sap, therefore, holds in solution, or in a temporarily insoluble condition, all of those substances which are necessary to the nutrition of the plant; and those substances also which are by-products of the chemical activities of the plant, such as the alkaloids, which probably serve no physiological purpose, and the tannins and glucosides, whose function is not yet apparent. The blue and red colors of flowers and variegated foliage are usually due to a coloring matter in solution in the cell-sap termed anthocyanin, which assumes a red color in acid solutions, and a blue or violet color in alkaline solutions.

The Cell-wall.—When new cells arise by division, the plane of separation is first demarked by a plasma membrane, which later changes over into cellulose and becomes the dividing wall. The swarm spores of Algæ and Fungi, and the sexual cells of higher plants, have at first merely a plasma membrane to cover them. Cells which are thus destitute of a cell-wall are termed primordial cells. It appears, however, that the plasma membrane is capable of becoming converted into cellulose, so that newly formed cells are very early provided with a cell-wall of cellulose. Cellulose, $C_6H_{10}O_5$, is well adapted to form the protecting wall about young and

growing cells because of its permeability to liquids and gases, and its ductility. In virtue of these properties of its wall the young cell is able to obtain its necessary food materials, and it is not so bound in as to be incapable of increase in size. After its first formation the cell-wall increases in surface and in thickness. The increase in surface is accomplished by the stretching of the wall due to the turgidity of the cell and the subsequent deposition of new particles of cellulose within or upon the wall already formed. If the deposition of new particles takes place within the wall, the process is called growth by intussusception, while the addition of new cellulose to the inner surfaces of the wall is called growth by apposition. Growth by apposition necessarily involves increase in thickness of the cell-wall. Growth in thickness is usually accomplished by the addition of new material to the inside of the wall; but where the outside surface is free, as in the case of pollen grains and epidermal cells, new material is apparently added to the outside as well, and sometimes in such a way as to give rise to excrescences of various forms. The growth in thickness does not, as a rule, occur uniformly. It is usually the case that on certain portions of the cell-walls new material is but little deposited, so that, however thick the remaining portions of the walls may become, easy osmotic communication is maintained between the cells throughout their life (Fig. 296).

Various forms of unequal growth in thickness of the cell-wall, which have a definite physiological significance, will be discussed in connection with the tissues in which they occur.

As the plant body becomes larger, both in its ontogenetic and phyllogenetic development, it becomes subject to greater dangers, such as too great loss of water, the attacks of parasites, and mechanical injuries due to breaking, crushing, and bruising. Accordingly, modifications of the cellulose wall have come about which contribute to its impenetrability to liquids and gases and to its hardness and elasticity.

Cutinized or *suberized* cell-walls usually occur when cells are exposed directly to the air, as is the case with epidermal and cork cells and pollen grains and spores.

The suberin and cutin, which give character to the suberized and cutinized walls, are nearly allied, but not identical, substances. Both cutinized and suberized membranes react alike to the various stains, and chemical analysis shows that both are fatty bodies composed of glycerine esters, and other substances which are not soluble in chloroform; both are nearly impervious to water and gases, and both serve the same physiological function, namely, chiefly that of preventing too great loss of water to the plant.

Lignified cell-walls, occurring in wood, bast, and stone cells, are char-

acteristic of those cells which have the purpose of giving strength, elasticity, and hardness to the plant. Since the strength and rigidity of plants must depend to a great extent on the character of their cell-walls, we find lignified walls reinforced for their office by being more or less

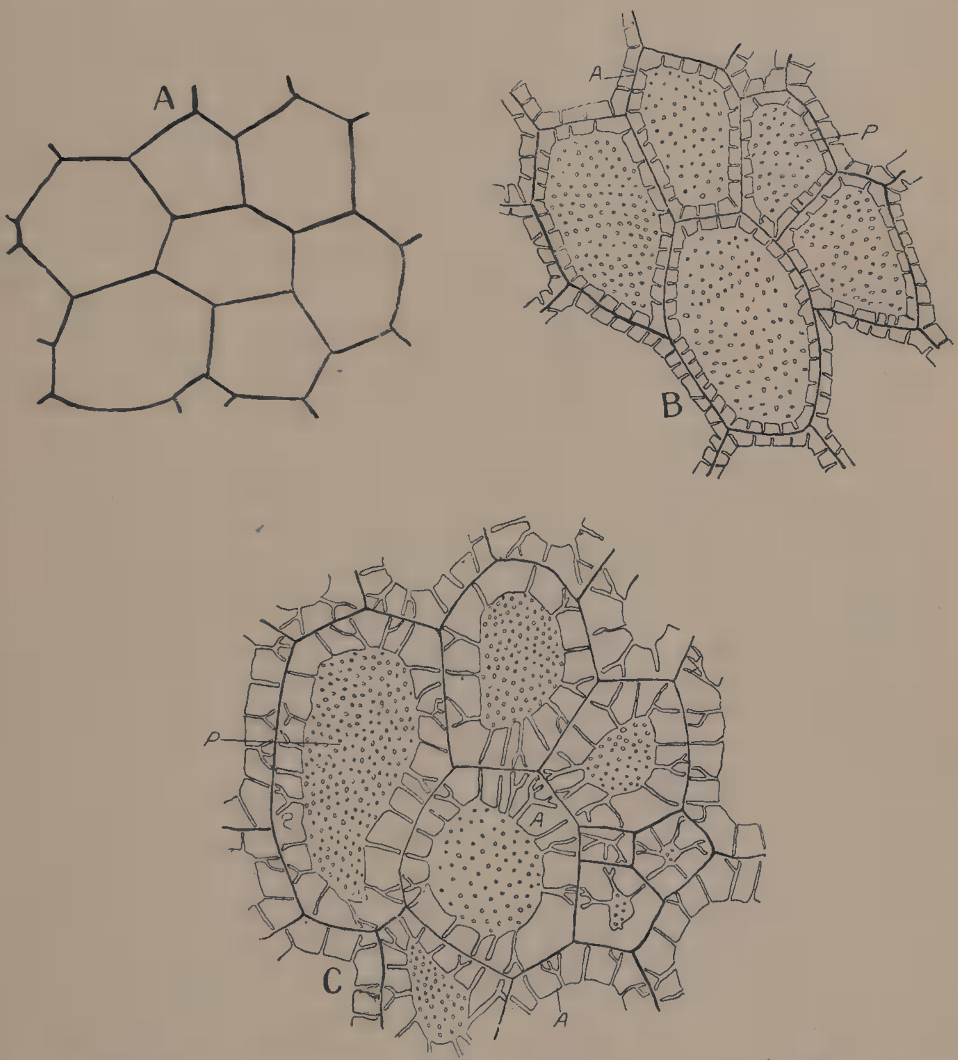

FIG. 296.—A, B, and C. Successive Stages in the Formation of the Stone Cells of the Peach. A. Thin-walled parenchyma cells of the fundamental tissue of the ovary of the peach; the walls are of cellulose. B. Later stage in which the walls have become thickened and lignified. At A and *P* are pits in the walls which facilitate the passage of materials to the still-growing cells. Section taken from a half-grown peach. *C*. Still later stage from the hard stone of a mature peach; many of the pits have united, forming a single-branched pit.

thickened. It may, in fact, be stated as a rule that lignification is associated with a thickening of the cell-wall. Lignified membranes are colored yellow with sulphuric acid and iodine or with chlor-zinc-iodide, but after treatment with Schultze's macerating fluid, and further treatment with sulphuric acid and iodine or chlor-zinc-iodide, they assume the char-

acteristic color of cellulose. This suggests the conclusion that lignification is due in part to the infiltration of the cellulose wall by the lignifying substances. The composition of the lignifying substance, which has been termed *lignin*, has not yet been definitely determined; but recent researches seem to have shown that there is no single lignifying substance, and that the so-called lignin is rather a combination of various substances, probably from the aldehyde group. The physical effect of lignification is to increase the hardness and strength of the membrane and to increase its permeability to water. Lignified walls consist commonly of three distinct layers (Fig. 297)—the middle layer *C*, which is dissolved in Schultze's macerating fluid, the lignified layer *B*, and the cellulose layer *A*.

Mucilaginous cell-walls occur in the seed coats of flax and quince, in the cotyledons of many Leguminosæ, and in the parenchyma cells of the Malvaceæ. In these cases the mucilage is deposited in layers against the inside of primary cellulose walls. The mucilaginous membranes have the same percentage composition as cellulose, but they differ from it by their power of swelling up enormously when placed in contact with water. Mucilaginous walls may serve the purpose of taking up and holding large quantities of water against times of drought, or they may in other instances serve as reserve food material, or, where they occur in seed coats, they may assist in holding the germinating seeds to the soil.

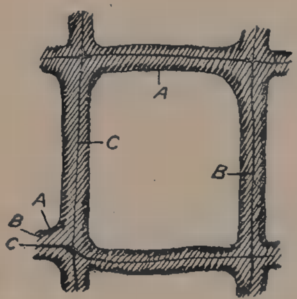

FIG. 297.—Cross-section of a Cell with Lignified Walls. *A*. Cellulose layer. *B*. Lignified layer. *C*. Middle layer.

Mineral deposits frequently occur in or upon cell-walls. Silica occurs notably in the grasses and Equisetaceæ; calcium oxalate sometimes occurs in walls in the form of crystals; and calcium carbonate occurs in the walls of certain Algæ, in the hairs of many Boraginaceæ, and in the peculiar growths from the walls of the epidermal cells of many Urticaceæ, Moraceæ, and Acanthaceæ, known as cystoliths. Mineral deposits add to the hardness and brittleness of the cell-walls; in the case of cystoliths, however, the calcium carbonate probably serves the purpose of reserve material.

Reserve Materials.—Reserve materials within the cells are those substances which have been manufactured by the plant for its own food above the amount necessary for its immediate use, such as starch, sugars, inulin, fatty oils, and the hemicelluloses, and the protein and aleurone grains, crystalloids, and undifferentiated protoplasm among the nitrogenous substances.

Starch, which occurs always in the plastids, and chiefly in the chloroplastids or leucoplastids, in the form of rounded or polyhedral bodies,

consists of various carbohydrates of the formula $C_6H_{10}O_5$, together with an inconstant amount of water and mineral inclosures. According to Arthur Meyer, starch-grains are sphærocrystals of amylose and amylodextrine, in which the amylose occurs in two modifications—α-amylose, which is not soluble in water at 100° C., and β-amylose, which dissolves in water at 100° C. α-Amylose may be isolated by treating starch paste with malt extract, or by the influence of dilute hot hydrochloric acid on whole starch-grains. That portion of the starch-grains which remains after this treatment is α-amylose, which differs from the portion of the starch-grains removed by the treatment in being insoluble in boiling water and in being colored pale red instead of blue by potassium-iodide-iodine. The β-amylose is dissolved in water at about 60° C., and this solution is colored blue with potassium-iodide-iodine. Starch-grains are seen to be either concentrically or excentrically striated (Fig. 298). Ac-

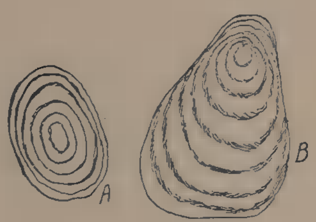

FIG. 298.—*A*. Concentrically striated starch-grain of the garden bean. *B*. Excentrically striated starch-grain from the potato.

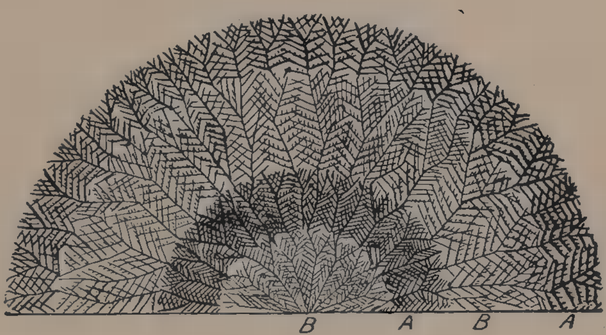

FIG. 299.—Schematic Representation of the Structure of a Starch-grain. The denser layers of crystals, *A*, *A*, are deposited during the day, and the less dense layers, *B*, *B*, during the night.—(*After Meyer*.)

cording to Meyer, the starch-grains are built up of fine needle-shaped crystals of the amyloses and amylodextrine which are disposed radially in the striations or laminæ. Alternate layers of the laminæ differ in the degree of compactness of the needle-crystals which form them (Fig. 299). Meyer was able to show that the cause of the striations was the different amount of organized material available for starch formation during the hours of daylight and darkness. Thus, in the daytime, when the chloroplasts are constantly supplying the necessary materials, the needle-crystals were laid down compactly as at *A*, *A*; but in the night-time, when the chloroplasts had ceased their activity, a less number of crystals were formed in a unit of volume, *B*, *B*; in the daytime a dense layer of starch was formed, and in the night-time a less dense layer. If the starch-grain has a central position in the plastid, the striations are formed concentrically; but if the growing grain has an excentric position, the striations

will be thicker on the side to which the greater thickness of plastid is applied. Starch, being insoluble in the cell-sap, can not pass from cell to cell until it has been dissolved by means of the ferment diastase, which is evidently formed by the plastid which contains the starch. Under the influence of the diastase the amyloses of the starch are first changed to amylodextrine, then to dextrine, isomaltose, and maltose respectively.

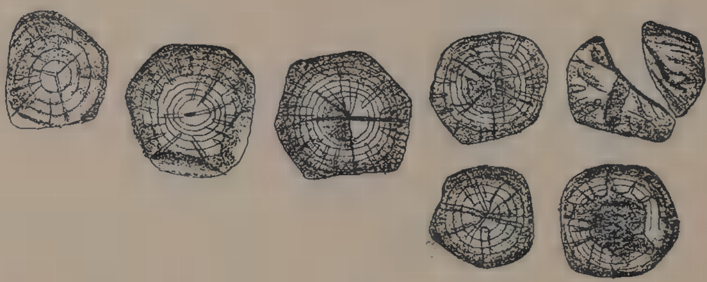

FIG. 300.—Starch-grains showing the Solvent Effect of Diastase.—(*After Meyer.*)

The diastase is able to penetrate into the deeper layers of the starch-grain, and the solution of the latter may therefore take place internally as well as externally (Fig. 300).

Hemicelluloses are those extreme thickenings of the cell-wall which occur in seeds especially, and which are dissolved by the action of diastatic ferments during germination and used in the nutrition of the developing plant. The thickened cell-walls of the date seed (Fig. 301) fur-

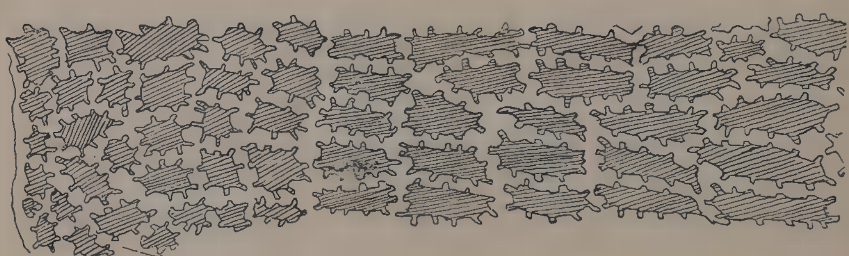

FIG. 301.—Section from the Endosperm of Date Seed. The shaded portions represent the cell cavities; the unshaded portions, the thickened cell-walls of hemicellulose, which, on the germination of the seed, become converted into sugar by the action of a diastatic ferment, and absorbed by the germinating embryo.

nish an example of this form of reserve material. Other examples may be found in the seeds of some Umbelliferæ and Leguminosæ, and in the seeds of many monocotyledonous plants. The hemicelluloses differ from cellulose in forming glucose when acted on by hot dilute mineral acids, and in the products yielded by hydrolysis with sulphuric acid. In many Leguminosæ the thickening of the cell-walls is due to a mucilage which

has either been formed directly as such or has arisen through changes in layers of the cell-wall which were originally cellulose. Nearly allied to the hemicelluloses is the reserve material, termed amyloid, which forms a part of the thickened cell-walls in the seeds of *Tropæolum majus*, *Impatiens balsamina*, and many other plants.

Sugar in the form of sucrose, or cane-sugar, $C_{12}H_{22}O_{11}$, exists as reserve material in the roots of beets; and glucose, or grape-sugar, $C_6H_{12}O_6$, occurs in the bulbs of onions.

Inulin, $C_6H_{10}O_5$, occurs dissolved in the cell-sap of many plants. It is very abundant in the tubers of *Dahlia variabilis*, *Helianthus tuberosus*, *Inula Helenium*, and in the roots of *Taraxacum officinalis*. On long standing in alcohol, inulin is precipitated from its solution in the form of sphærocrystals (Fig. 302). Inulin is converted into grape-sugar before it takes part in the nutrition of the growing plant.

Fats and oils occur as reserve materials in the seeds of many plants; thus, castor oil occurs in the seeds of *Ricinus communis*, and linseed oil in the seeds of *Linum usitatissimum*. The oils which serve as reserve materials are fixed oils, and are mixtures of free fatty acids with glycerine compounds of fatty acids. When oily seeds germinate, the oil is split up into its acid and glycerine; later sugar and starch are formed, and finally the starch is converted into sugar.

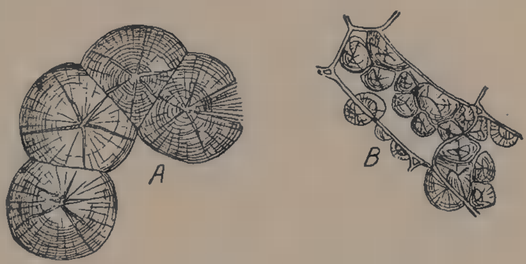

FIG. 302.—*A*. Sphærocrystals of inulin from tuber of *Dahlia variabilis*, which have been precipitated from an aqueous solution. *B*. Sphærocrystals of inulin which have been precipitated within the cells by long standing in alcohol.—(*After Sachs.*)

The reserve oils appear to be always formed in the protoplasm of the cell in the form of exceedingly small drops which are so uniformly distributed throughout the protoplasm as to give the appearance of an emulsion; when the cells are cut open, however, the droplets run together to form larger masses.

The reserve materials which have been thus far spoken of contain no nitrogen, and may be classed as the non-nitrogenous reserve materials. Nitrogenous reserve materials occur either as undifferentiated substances in the protoplasm or as sharply differentiated bodies in the form of rounded grains or crystals.

Protein grains or aleurone grains are rounded bodies of proteid substances occurring as reserve material in the endosperm of seeds. In starchy seeds they are usually small granules filling the space between the starch-grains (Fig. 303); in oily seeds they are larger, as a rule, and differ-

entiated into a ground substance and a crystalloid of proteid materials, usually associated with rounded bodies known as globoids, which consist of a double phosphate of magnesium and calcium. Both the crystalloid and the globoids are inclosed in the ground substance, which in its turn is imbedded in the cytoplasm of the cell (Fig. 304). Crystalloids of proteid substances also occur outside of aleurone grains. They have been found in the plastids, in nuclei, and in the general cytoplasm of the cell. They may be found, for instance, in the cells immediately beneath the

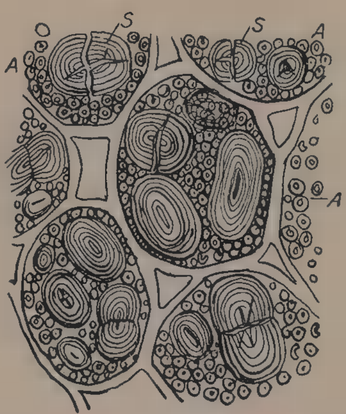

FIG. 303.—Section from the Cotyledons of a Seed of *Pisum sativum*, showing aleurone grains, *A*, and starch-grains, *S*.—(*After Sachs.*)

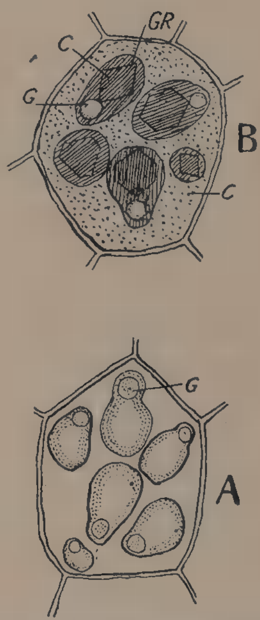

FIG. 304.—Cells from the Endosperm of *Ricinus communis*. A. As seen when the section is mounted in oil. The globoid is seen clearly at *G*, while the rest of the grain appears almost homogeneous. B. As seen when the section is treated with a solution of potassium-iodide-iodine. The grain is thus differentiated into the ground substance, *GR*, the crystalloid, *C*, and the globoid, *G*. The cytoplasm of the cell in which the grains are imbedded is represented with a granular appearance, as shown at *C*, on the right.—(*After Frank.*)

corky layer of the potato. The proteid crystalloids differ from mineral crystals, aside from their chemical constitution, in their reaction to stains and in their swelling up before going into solution with certain reagents, such as caustic potash and chloral hydrate.

Before the nitrogenous reserve materials are used in the growth of the plant they are converted by the action of proteolytic ferments into the simpler and more soluble peptones, and these again into the still less complex amido-compounds, such as asparagin and leucin.

Mineral Crystals.—Mineral crystals are of frequent occurrence in

the cells of plants; they are, however, for the most part, waste products and can not be classified as reserve materials.

Calcium oxalate occurs quite frequently in the cells of all parts of the higher plants. It occurs most commonly, however, in the parenchymatous tissues of roots, stems, and leaves. The crystals of calcium oxalate occur in various forms (Fig. 305), either singly in a cell or in clusters; as octahedra of various forms; or as needle-shaped crystals, called raphides. Sometimes the cells which bear the crystals are distinguished by their

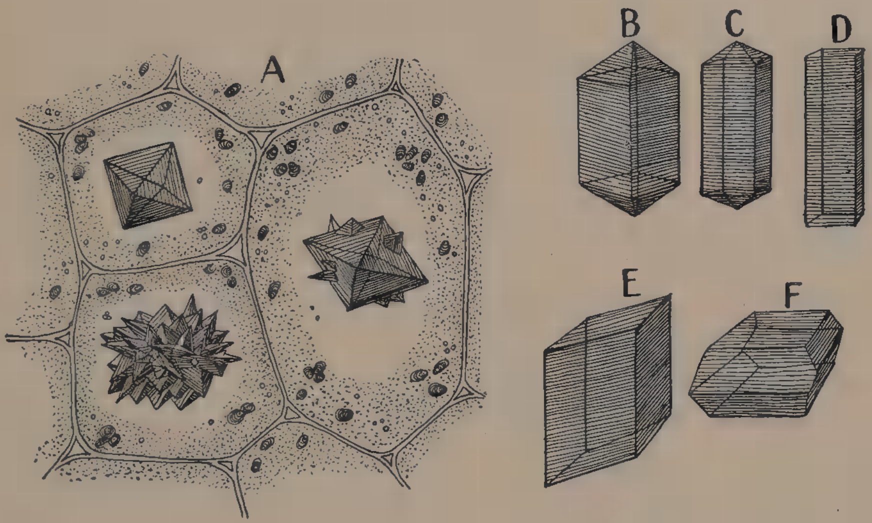

FIG. 305.—Crystals of Calcium Oxalate. A. From the petiole of *Begonia manicata*, in the form of octahedra and compound crystals. B–F. Various other forms of calcium oxalate crystals.—(*After Krug.*)

form or size, but more frequently they do not differ from the other cells of their tissue.

Calcium carbonate occurs in the crystalline form in the plasmodia of Myxomycetes and in the cells of the seed coats of some plants.

Calcium sulphate is found as minute crystals in many desmids; the crystals are particularly evident in the vacuoles at the ends of the cells of Closterium.

Silica occurs as masses of various shapes in the cells of many plants, as in the Magnoliaceæ and Orchidaceæ.

Other cell contents, such as the alkaloids and tannins, are discussed sufficiently for our purpose in the chapters on Microtechnic.

CHAPTER IV.—CELL FORMATION.

The formation of new cells may come about in various ways; but by whatever process, it is always essentially the aggregation of protoplasm about new centers of formation. The organs of the protoplast of the new cell are, with exception of the plasma membrane, always provided by the division of those already present in the parent cell.

Rejuvenescence is the process by which the protoplast of a cell already present liberates itself from its cell-wall, and so becomes free to enter upon a new phase of existence. This process occurs only in the formation of reproductive cells. A good illustration is found in the formation of the swarm spores of Œdogonium (Fig. 306). It will be seen that the entire protoplast of one of the cells which constitutes the algal filament emerges from its cell (*A* and *B*) and changes its form from cylindrical to egg-shape (*C*). There is a hyaline region at the smaller end encircled by a crown of cilia, the vibrations of which cause the movements of the swarm spore in the water. After the swarm spore comes to rest the hyaline end expands into a sucker-like disk (*D*) which holds the spore to the substratum, while the larger green end grows forth to form a new filament as soon as the spore has formed a wall about itself. That, in the formation of the spore, a radical re-organization of the cell takes place is shown by the fact that the polarity of the cell has shifted through 90 degrees, for the hyaline and opposite ends of the spore correspond to the ends of a short diameter of the original cell.

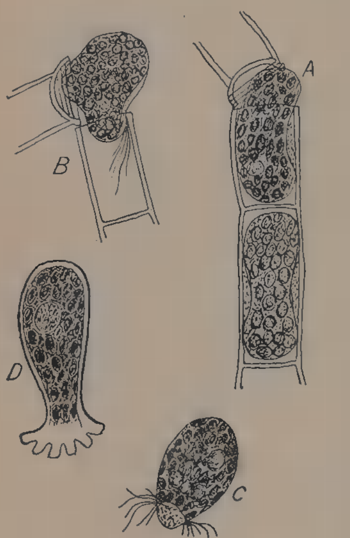

FIG. 306.—Formation of Swarm Spore by Œdogonium. *A* and *B*. Protoplast emerging from its cell. *C*. Protoplast differentiated into green end and hyaline end with crown of cilia. *D*. A later stage of the swarm spore *C* after it has become attached to a substratum and has commenced to elongate in the form of a new filament.—(*After Pringsheim.*)

Conjugation.—New cells may arise by conjugation—that is, by the fusion of two protoplasts from previously distinct cells. A good example of this process is found in Spirogyra, a fresh-water Alga found in ponds and running streams. Each cell of this filamentous Alga (Fig. 307) contains a chloroplast in the form of a spiral band, *S*, and a nucleus, *N*, suspended near the center of the cell by cytoplasmic radiations. Conjugation takes place between the cells of two filaments which happen to

be lying near together and are more or less parallel to each other. Conjugation proceeds as follows: Two cells of adjacent filaments grow out toward each other until they come in contact (*A*, *B*, and *C*, Fig. 307); then the protoplasts of the two cells contract, probably by the expulsion of water from the cell-sap, and assume a rounded form, in consequence of which their parts undergo a considerable rearrangement; then the wall which separates the two cells becomes resorbed, and the protoplast from

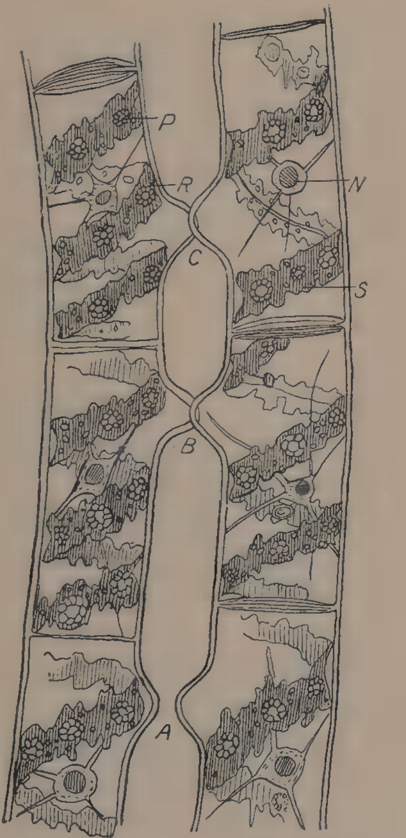

FIG. 307.—Copulation of *Spirogyra longata*. At *A* two cells of adjacent filaments have commenced to grow toward each other. At *B* and *C* the outgrowths have grown together.—(*After Sachs.*)

FIG. 308.—A. The protoplast of one cell is flowing over to the adjoining cell of an adjacent filament and fusing with its protoplast. At *B* the union of the protoplasts is complete. B. At *C*, *C* the zygospores formed by the union of two protoplasts have formed a wall about themselves preparatory to entering on a period of rest.—(*After Sachs.*)

one cell glides through the connecting canal into the other cell, where the two protoplasts fuse together completely, nucleus with nucleus and cytoplasm with cytoplasm (*A* and *B* in A, Fig. 308). The protoplast thus formed clothes itself with a cell-wall and becomes a so-called zygospore (*C*, *C*, in B). The spore becomes free from the parent cell by the disintegration of the walls of the latter, and after passing through a resting period of several months, the spore germinates into a new Spirogyra filament.

Cell Division.—The formation of cells by cell division involves the division of the protoplast of a parent cell and the distribution of the divided organs of the parent between the daughter protoplasts. The nucleus being the bearer of the inheritable qualities, is divided with extreme accuracy between the daughter cells by a process known as karyokinesis. The steps in this process will now be given. The resting nucleus consists of a nuclear framework (*F* in A, Fig. 309), which is formed by a thread coiled into numberless convolutions which unite where they touch, and so form an orbicular network which traverses the entire nucleus. When fixed and stained, the thread is seen to consist of alternating disks of colored and colorless substances termed chromatin and linin respectively. One or more nucleoli, *N*, are suspended within the meshes, and the remaining space inclosed by the nuclear membrane is filled by the nuclear sap. The first stages in the process of nuclear division are marked by a thickening of the nuclear thread. The thread continues to thicken and at the same time to shorten until the original network has been converted into the thick and coiled thread shown at *T* in B. At about this time the thread is often seen to have divided longitudinally. The double thread then divides transversely into segments, which are called chromosomes, the number of which is constant within a species, but may vary in different species. About this stage the nuclear membrane becomes dissolved, the nucleoli disappear, and the kinoplasmic spindle is formed, radiating toward the equator from opposite poles (*S*, *S*, in C). The chromosomes then become arranged at the equator and attached to the spindle-fibers in the form of a ring or plate (*C* in C and D). Then the longitudinal halves of each chromosome are drawn by the contracting spindle-fibers to opposite poles, where they unite to form the nuclear thread of the daughter nuclei (E, F, G, H, and I). Later, the nuclear thread goes over into the nuclear framework, a nuclear membrane is formed, the nucleoli reappear, and the daughter nuclei enter into their resting stage (J and K). After the chromosomes have collected at the poles, and even after the daughter nuclei have been fully formed, kinoplasmic fibers remain stretched from pole to pole. Thickenings arise on these fibers at the equator (*F* in I) which unite to form a membrane called the cell-plate (*P* in J and K). This increases in diameter in the two dimensions of its plane until it completely separates the mother cell into two daughter cells, each with a nucleus formed by the division of the nucleus of the mother cell, as just described. The connecting fibers finally disappear and the cell-plate becomes transformed into a cellulose wall.

The longitudinal division of the nuclear thread and the distribution of the halves of each chromosome to opposite poles insures a very exact division of the mother nucleus between the daughter nuclei, and in con-

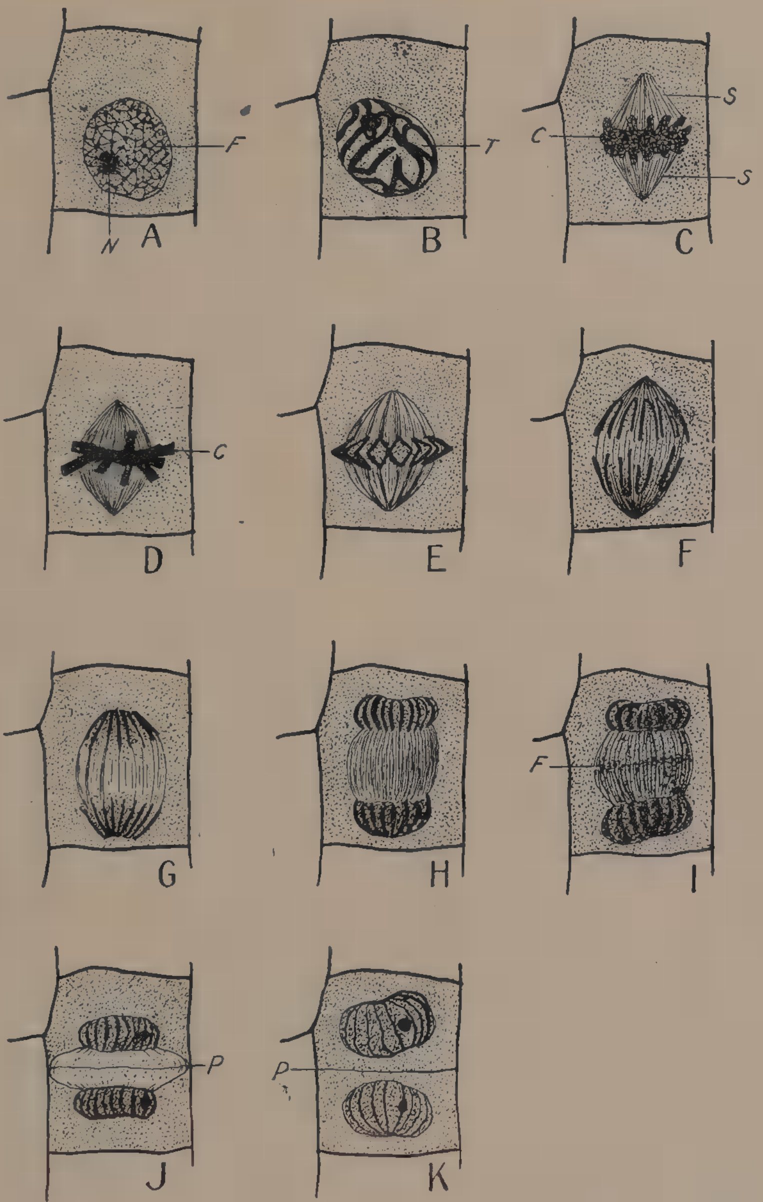

FIG. 309.—Different Stages of Indirect Nuclear Division, resulting in Cell Division. A. Resting nucleus, nucleolus at *N*, and nuclear network, *F*, filling the entire nucleus. B. Early prophase. Nuclear network has lost its reticulated character and has assumed the form of a loosely coiled thick thread; nucleolus still present. C. Nuclear thread has become divided into chromosomes, which have gathered at the equator of the cell. The spindle-fibers which converge at the poles are connected with the chromosomes; the nucleolus has disappeared. D. Late prophase. The chromosomes have divided longitudinally. E. Early metaphase. The longitudinal segments of the chromosomes are being drawn apart, one of each pair of segments toward opposite poles. The contracting spindle-fibers are instrumental in this translocation of the chromosomes. F, early, and G, late, anaphases. In G the chromosomes have arrived at the poles, where they will soon fuse together to form the daughter nuclei, as shown in the succeeding stages of H, I, J, and K. The stages from H to the formation of the resting daughter nuclei are known as the telophases. In I, thickenings of the connecting fibers have arisen. At J the connecting fibers have moved out to the sides of the cell, and the equatorial plane of thickening on the fibers constitutes a complete septum separating the mother cell into two daughter cells, each having a nucleus which has arisen by the division of the nucleus of the mother cell. In K the septum has become changed to cellulose. In J and K the nucleoli have reappeared. The daughter nuclei shown in K will soon pass into the resting state shown at A, where the nuclear thread has a reticulated form.

sequence an equal possession by the daughter cells of the inheritable qualities from the parent cell. So far as accurate observations extend, this is the method of cell formation which generally prevails in the growth of plants and in the formation of the reproductive cells of Phanerogams and many Cryptogams.

Free Cell Formation.—In cell formation by cell division, as described above, the daughter cells have a common wall, or at least a common cell-plate, which may remain intact or may separate into two layers, so that before or soon after the cellulose wall is formed the daughter cells become separated from each other, as in the case of some spores and

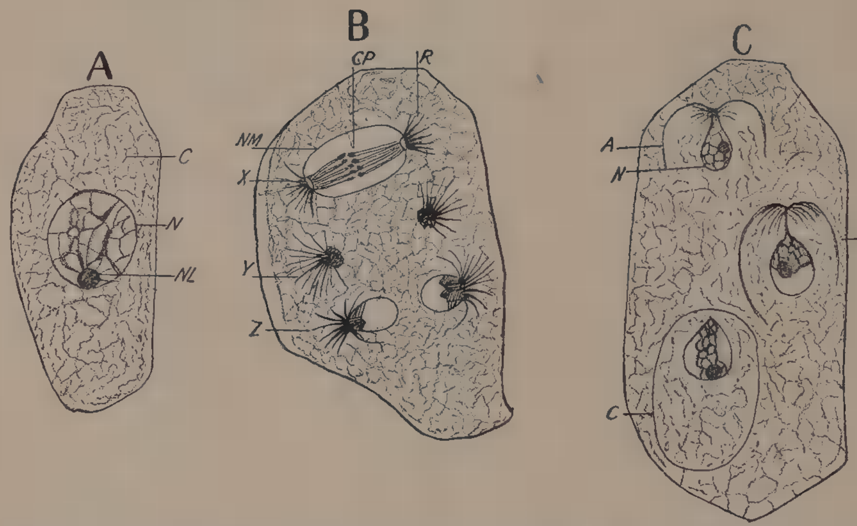

FIG. 310.—Free Cell Formation of Spores in the Ascus of *Erysiphe communis*. A. Ascus with single nucleus, *N*; cytoplasm, *C*; nucleolus, *NL*. B. Successive stages in nuclear division within the ascus; at *X*, early anaphase, nuclear membrane, *NM*, still persisting; *R*, kinoplasmic radiations from the poles; at *Y*, telophase, new nuclear membrane not yet formed; *Z*, a later stage where the nuclear membranes demark the daughter nuclei. C, *A*, *B*, and *C* are successively later stages than *Z* in B. At *A* certain of the kinoplasmic radiations are bending downward about the nucleus, *N*; at *B* the nucleus is nearly inclosed, and at *C* entirely inclosed by the radiations, which now form a complete membrane, cutting off a portion of the cytoplasm of the ascus, and thus forming a complete cell. (Arranged after drawings by Harper. B and C are diagrammatic; for the sake of simplicity of description, various stages of nuclear division are shown in a single ascus, although at any given period only one stage would actually be present.)

pollen grains. In the case of free cell formation, however, the daughter cells are entirely free from each other from the time of their first formation. An excellent example is found in the formation of the ascospores of *Erysiphe communis*. In the young ascus there is a single nucleus (*N* in A, Fig. 310), but this divides, producing two nuclei, and these divide and give rise to four nuclei which lie free in the cytoplasm of the ascus. During the first and second divisions the kinoplasmic radiations from the poles, shown at *R* in B, gradually disappear after the formation of the daughter nuclei. The four nuclei finally divide to form eight nuclei, but in this instance after the formation of the daughter nuclei

certain of the kinoplasmic radiations persist and gradually bend about the nucleus (A and B in C), forming a closed membrane (C in C), which demarks the nucleus, together with a certain amount of the cytoplasm, from the general cytoplasm of the ascus, forming a cell which is distinct and free from the other cells of the ascus which have been formed in like

FIG. 311.—Gonidangium of an Achlya. *A*. Closed and filled with zoogonidia. *B*. Escaping zoogonidia; *a*, zoogonidia which have just escaped; *b*, membranes which have been abandoned by swarming zoogonidia, like those at *e*; *c*, a lateral branch.—(*After Sachs.*)

FIG. 312.—Various Stages of Cell Multiplication by Budding of *Saccharomyces cerevisiæ*.—(*After Reess.*)

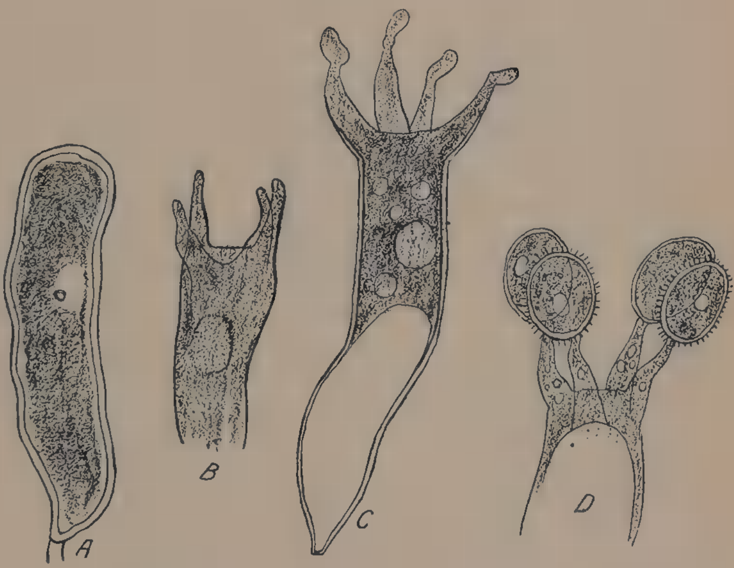

FIG. 313.—Spore Formation by *Corticium amorphum*. *A*. Nearly mature basidium. *B*. Four sterigma are formed, from the ends of which the spores bud forth, as at *C*. *D*. Ripe spores.—(*After de Bary.*)

manner. In this instance the whole of the cytoplasm of the mother cell is not used in the formation of the daughter cells. In the formation of the swarm spores of many Algæ and Phycomycetes the whole of the cytoplasm of the mother cell is used in the formation of the daughter cells. In the formation of the zoospores of an Achlya, for example (Fig. 311),

the whole of the cytoplasm becomes demarked into spores which break out from the parent cell and become entirely dissociated from each other.

Cell formation by budding differs from ordinary cell division in that the mother cell puts forth an outgrowth which becomes cut off by the formation of a wall at the place of its origin. This process of cell formation occurs in yeasts and in the formation of the conidiospores of many fungi (Figs. 312 and 313).

CHAPTER V.—THE TISSUES.

In all but the lowest forms the plant body consists of many cells united to form one or more systems of tissues which are adapted by their position, arrangement, and structure to perform more or less distinct physiological functions. In unicellular plants such a division of labor is, of course, impossible, and in the simpler multicellular forms, such as the filamentous Algæ and Fungi, the distribution of distinct functions to particular cells or groups of cells has made only a feeble beginning. In the Phanerogams and higher Cryptogams, however, the adaptation of special tissues to perform distinct functions has reached a marked degree of perfection.

A tissue—that is, a union of cells which have like structural characters and functions—may come about in various ways. Cells which were originally isolated may come together and be so intimately united where they touch each other that no separating line can be made out. This is illustrated by Pediastrum (Fig. 314). Here the protoplasts break up within the cells into many which finally escape from the parent cell-cavity surrounded by a thin membrane. Each of the daughter protoplasts becomes invested by a wall of its own, and, after moving about for a time within the common membrane the daughter cells unite to form a new Pediastrum aggregate (B and C, Fig. 314).

In the case of Lichens and many of the higher Fungi the plant body is composed of multicellular, filamentous threads, called hyphæ, which are so intimately interwoven and grown together as to form a uniform and compact tissue (Fig. 315).

In the majority of cases, however, and particularly in the higher plants, the tissues are formed by cells which have remained united by common walls from the time of their formation by cell division.

When cells are first formed by cell division, they are united along their entire surface, but later the cells tend to assume a more rounded outline, presumably because of hydrostatic pressure from within the cells, and the walls become separated at the corners where three cells meet (Fig. 316).

The fact that the middle lamella of walls which have begun to thicken

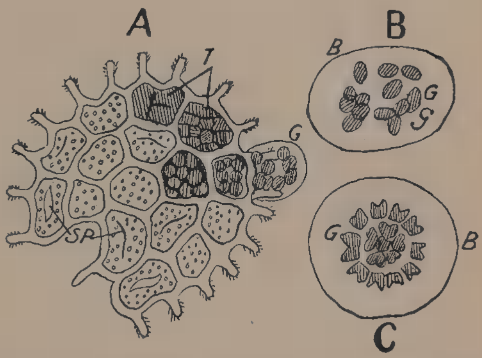

FIG. 314.—*Pediastrum granulatum*. A. Plant body of united cells. *T*. Different stages of cell division. At *G* the innermost layer of cell wall is protruding, and the daughter cells are escaping from the mother cell along with it. B. Daughter cells *G* surrounded by the inner lamella *B*, which has entirely freed itself from the mother cell; the daughter cells are in active motion. C. The same family of daughter cells four and one-half hours later; the daughter cells *G* have arranged themselves into a group similar to A and will soon unite to form a common tissue.—(*After A. Braun.*)

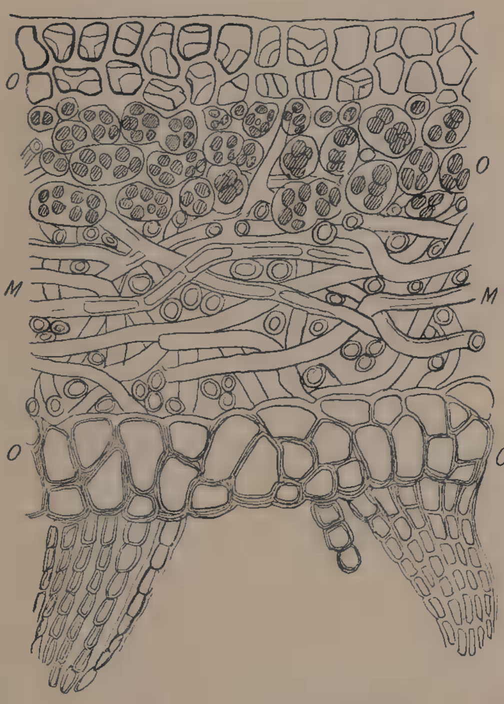

FIG. 315.—Cross-section through the Thallus of *Sticta fuliginosa*. At *M* the hyphæ are interwoven in the form of a tissue. Above and below *M* at *O* the hyphæ have become united in the form of a pseudoparenchyma. —(*After Sachs.*)

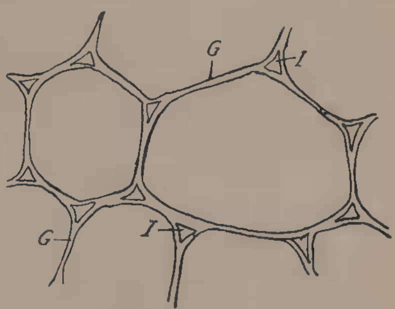

FIG. 316.—Cells from the Stem of *Zea Mais* showing intercellular space at *I*, and common wall at *G*.—(*After Sachs.*)

becomes altered to a calcium pectate, associated in suberized and lignified walls with lignin, contributes to the formation of intercellular spaces.

The protoplasts in the cells of a tissue have been demonstrated in many instances to be connected with each other by means of cytoplasmic threads which extend through the cell-walls (Fig. 317). These connections probably serve for the transmission of stimuli throughout a tissue, and so contribute to the harmonious action of the cells in their common physiological functions.

Intercellular Spaces.—The intercellular spaces have an important physiological significance. They arise by the separation of cells as already described, and are then called schizogenous, or they may be formed by

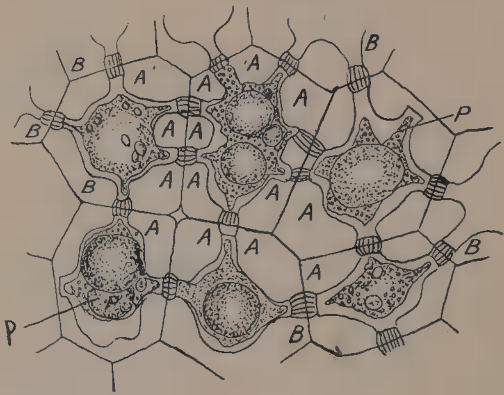

FIG. 317.—Cross-section through the Endosperm of *Areca oleracea*, after Treatment with Chloriodide of Zinc. The protoplasts (*P*) within the cells are somewhat shrunken from the walls through the action of the reagent. The walls of the cells are very much thickened, as shown at *A*, but pits occur at intervals, *B*. Fine threads of protoplasm connecting the adjoining protoplasts extend through perforations in the pits.—(*After Tangl.*)

the breaking down or resorption of cells, when they are called lysigenous. Most schizogenous intercellular spaces contain air, and so constitute an

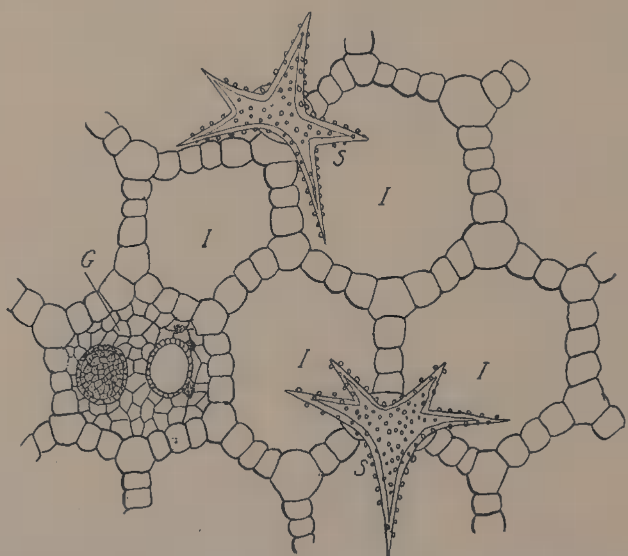

FIG. 318.—Cross-section through the Petiole of *Nuphar advena*. At *I* are large schizogenous intercellular spaces containing air. *S*. Star-shaped idioblasts. *G*. Vascular bundle.—(*After Sachs.*)

aërating system which reaches a marked development in leaves and in all parts of the more highly developed plants which grow in wet places or in swamps or entirely submerged in water (Fig. 318). However, some

schizogenous spaces, such as the resin ducts of pine and ivy, contain excretions. The lysigenous intercellular spaces contain, for the most part, products of secretion, such as resins, gums, and ethereal oils. In the case of the formation of lysigenous intercellular spaces certain groups

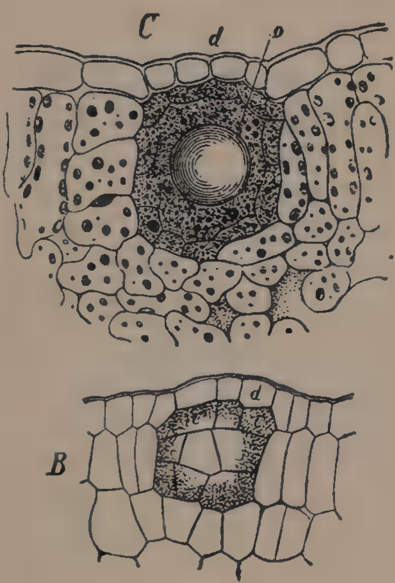

FIG. 319.—Lysigenous Oil-gland at the Upper Surface of the Leaf of *Dictamnus fraxinella*. *B*. An early stage in the formation of the gland where the mother cells (*C*) have not yet lost their identity. *C*. A mature gland; the mother cells have broken down and the oil secreted by them has fused into one large drop (*o*).—(*After Sachs.*)

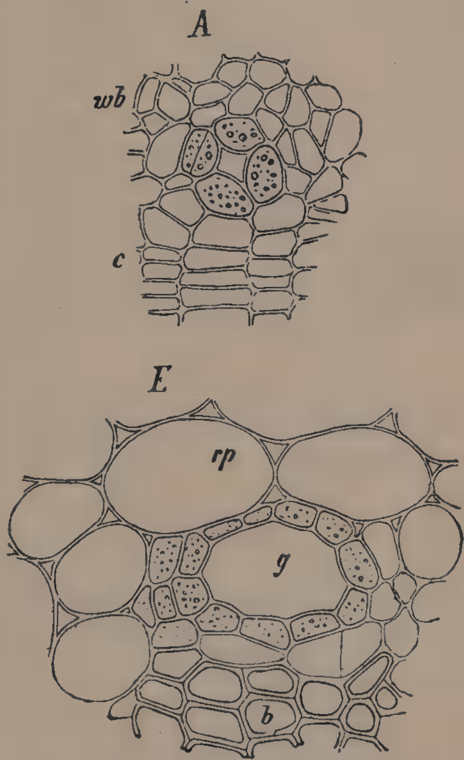

FIG. 320.—Schizogneous Resin Duct in the Young Stem of the Ivy (*Hedera helix*) as seen in transverse section. *A*, early, and *E*, later, stage in formation of the duct. *g*. The mature duct. *c*. The cambium. *wb*. The soft bast. *b*. Bast fibers. *rp*. Cortical parenchyma.—(*After Sachs.*)

of cells secrete substances such as ethereal oils or gums, and later the walls of the secreting cells break down and the secretion collects in the common intercellular cavity (Fig. 319).

CHAPTER VI.—THE TISSUE SYSTEMS.

The Meristematic Tissues.—In those plants in which division of labor has been carried to any considerable extent, notably in the Phanerogams and higher Cryptogams, growth by cell multiplication takes place

in certain distinct regions, as at the apex of stems and roots and in the cambium and cork-cambium zones. The tissues of these regions which retain the power of active cell division are called meristematic tissues. Since stems and roots increase in length by the division and subsequent enlargement of the meristematic cells at their apices, these apical meristematic tissues are the ultimate source of all the other tissues, and are therefore classed as the Primordial Meristem (*P*, Fig. 321). A short distance back from the apex the primordial meristem becomes differentiated into three distinct tissues. At *E* are cells which have elongated somewhat longitudinally, and which, by their continued division, are to give rise to the epidermis; these constitute the *protoderm*. At *C* are cells which have elongated considerably in proportion to their length and which, by continued division and subsequent fundamental changes, are to produce fibrous and vascular tissues. Some of the cells, however, are to retain their power of continued division and constitute the cambium tissues of the older portion of the stem; these elongated cells at *C* are the *procambium*. The remaining tissue of the stem (*G G*) just below the apex is known as the *ground* or *fundamental meristem*. Protoderm, procambium, and ground meristem are termed collectively the Primary Meristem.

The cells of the meristematic tissues are distinguished by being relatively small, thin-walled, with a protoplast filling almost the entire cell, and have the power of continued division. The cells which arise through the division of the meristematic cells soon undergo changes in form and structure which demark them sharply from the meristematic cells and which fit them for the performance of special functions, and, with the exception of those cells which are to produce the interfascicular cambium and the cork cambium, they lose the power of division, although in some cases the power may be revived under the stress of special need. The cork cambium and interfascicular cambium are classified as Secondary Meristem, while the tissues which arise through the division of the primary meristems are called Permanent Tissues, because their cells, in contradistinction to the meristematic cells, soon assume a definite and permanent character, with the exception of those which are to give rise to the secondary meristems.

While in Dicotyledons the formation of permanent tissues proceeds toward the apex, so that the maturer tissues are found toward the bases of the nodes, in the case of the leaves of most Monocotyledons and the internodes of the Gramineæ primary meristem is still found at the bases when the upper portions have become permanent. Such plants are able to grow in length not only by the division of the cells of the primordial and primary meristems of their growing points, but also by the division

FIG. 321.—Longitudinal Section through the Apex and Three Succeeding Joints of Stem of *Ulmus Americanus*. At *P* primordial meristem. *C*. Procambium. *G*. Ground meristem. *V*. Spiral vessel bounded exteriorly by young wood-fibers. *E'*, *G'*, *C'*. Tissues which have nearly reached the permanent condition, which in their meristematic condition were *E*, *G*, and *C* respectively. *L*. Young leaves. *Y*. Axillary buds. *X*. Position of older leaf.

of the cells of the primary meristem at the bases of a considerable number of internodes.

The cells of the permanent tissues may be classified as parenchymatous when their three dimensions are of about the same length, and they for the most part remain thin-walled and retain their protoplasts; and as prosenchymatous when one dimension becomes considerably longer than the others, and the cells for the most part become thick-walled and lose their protoplasts. These classes of cells gradually grade into each other, however, and no hard-and-fast distinction can be made, excepting in the extreme cases.

The Tegumentary Tissues.—The Pteridophytes and Phanerogams possess a tegumentary system of tissues which covers the entire plant and has for its functions the protection of the deeper-lying tissues from mechanical injuries, the attacks of parasitic fungi, and the too great loss of water by evaporation. This is accomplished by the epidermal and cork tissues, the outer walls of the former being covered with cuticle which is almost impervious to water and gases, and the walls of the latter being suberized, with the result that they too are practically impervious to water and gases. However, in the case of some plants which are growing submerged in water, and in the case of the young roots of all plants, the epidermis is slightly or not at all cutinized, thus remaining in a condition suited to the absorption of water.

The epidermis arises by the division and subsequent differentiation of the cells of the protoderm. It is characterized by having no intercellular spaces (unless the openings in the stomata are so considered), by containing a large amount of water, by being, as a rule, destitute of chlorophyll, and by being covered by a thin and tough water-proof cuticle wherever its cells are exposed to the air. The epidermis consists, as a rule, of a single layer of cells; but in some cases, either by the tangential division of the protoderm or by a similar division of the epidermal cells themselves, the epidermis may be composed of more than one cell-layer, in which case it is termed a multiple epidermis. Sometimes the cells of the fundamental tissue immediately beneath the epidermis assume a character similar to the epidermis; at other times these cells become thick-walled and much elongated, when they serve more as strengthening than as protecting tissues. Such tissues are known as the *Hypoderma*.

The character of the cells of the epidermis differs with their immediate surroundings. The epidermis of those parts of plants which are exposed to the air and light, and so have as a principal function protection against too great loss of water, differs from that which covers parts of plants which are imbedded in the soil or submerged in water. Thus, the epidermis which is exposed to the air is apt to have its outer wall much

thickened and cutinized, and overlaid with a well-developed cuticle, while the epidermis of those parts of plants which remain covered with soil or water do not have these characteristics, the outer wall being relatively thin and non-cutinized. The cells of the epidermis are, as stated, without intercellular spaces, and are so firmly bound together that the epidermis can usually be stripped away from the underlying tissues as an intact layer.

The aërating structures of the epidermis, known as stomata, which commonly occur on an epidermis exposed to the air, have the power usually of opening and closing as the plant has need. The thick outer wall,

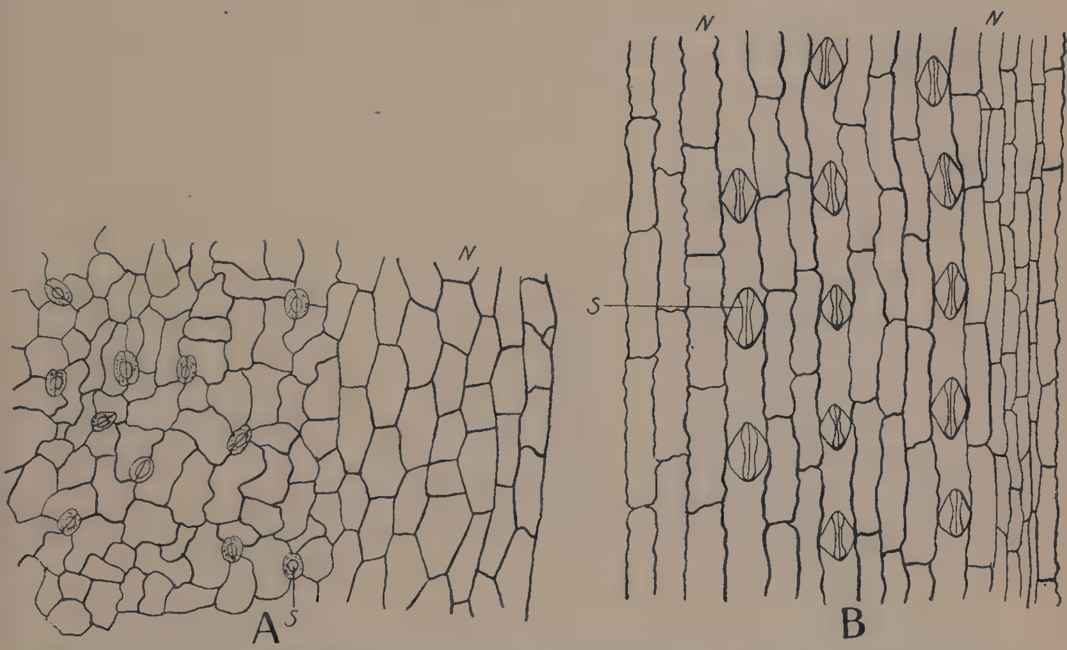

FIG 322.—A. Surface View of the Epidermis of Leaf of *Beta vulgaris*. *S*. Stoma. At *N* portion of epidermis covering a nerve where no stomata occur. B. Surface view of epidermis of leaf of *Avena sativa*.—(*After Frank*.)

and the cuticle covering it, also guard against mechanical injuries and the onslaughts of fungi.

The epidermal cells usually contain a relatively small protoplast which lines the cell-wall, and the remainder of the cell-cavity contains a very watery cell-sap.

Starch-grains and chloroplasts are usually absent from the cells of the epidermis, with the exception of the guard cells of the stomata.

The form of the epidermal cells usually depends on the shape of the structure which they cover. In structures such as fruits which are rounded, the epidermal cells seen from the surface appear isodiametric; while structures which are much elongated in one dimension, such as the leaves

of grasses, have their epidermal cells elongated in the direction of their long axis (Fig. 322).

The outer wall of the epidermis, which is its most important structure physiologically, often consists of three distinct layers—the inner or cellulose layer, the middle or cutinized layer, and the cuticle (Fig. 323). The cellulose layer and the cuticle are always present, while the cutinized layer is often absent, as in the leaf of *Allium cepa* (B, Fig. 323). The cutinized layer contains a large amount of cutin, and so assists the cuticle in preventing evaporation.

In addition to the cuticle there is often an incrustation of wax over the epidermis, which assists in reducing transpiration, and in preventing water from spreading out over the surface and closing the stomata (Fig. 324). It is the wax incrustation which produces the satiny bloom on the surface of the leaves of cabbage, water lilies, the fruit of the plum,

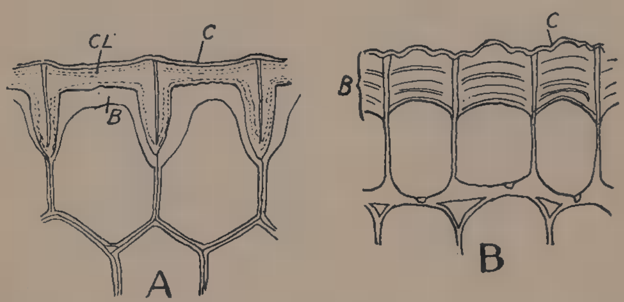

FIG. 323.—A. Cross-section of Epidermal Cells of the Leaf of *Aloë acinacifolia*. B. Similar section of a leaf of *Allium cepa*. C. Cuticle. *CL*. Cutinized layer. *B*. Cellulose layer.—(*After Haberlandt*.)

FIG. 324. — Rod-shaped Wax Coating over the Epidermis of *Saccharum officinarum*.—(*After Haberlandt*.)

etc. When water is thrown on the leaves of water lilies it gathers into drops and rolls off without wetting the leaves. If water were able to wet the leaves, it would, by capillarity, be drawn into the stomata, which would thus be prevented from performing their aërating function.

The radial and inner walls of the epidermal cells are much thinner than the outer walls; they are made of cellulose and do not, as a rule, become incrusted or infiltrated with cutin. They are, therefore, adapted to permit an easy interchange of materials between the epidermis and the deeper lying cells.

In most plants certain cells of the epidermis grow out beyond the general surface, attain to various sizes and forms, and become adapted to diverse functions. Such outgrowths of the epidermal cells are termed *trichomes*. The simplest trichomes are found on the surface of the petals of flowers, such as the pansy, where they have the form of short papillæ and give to the petals a velvety texture. The outgrowth of an epidermal

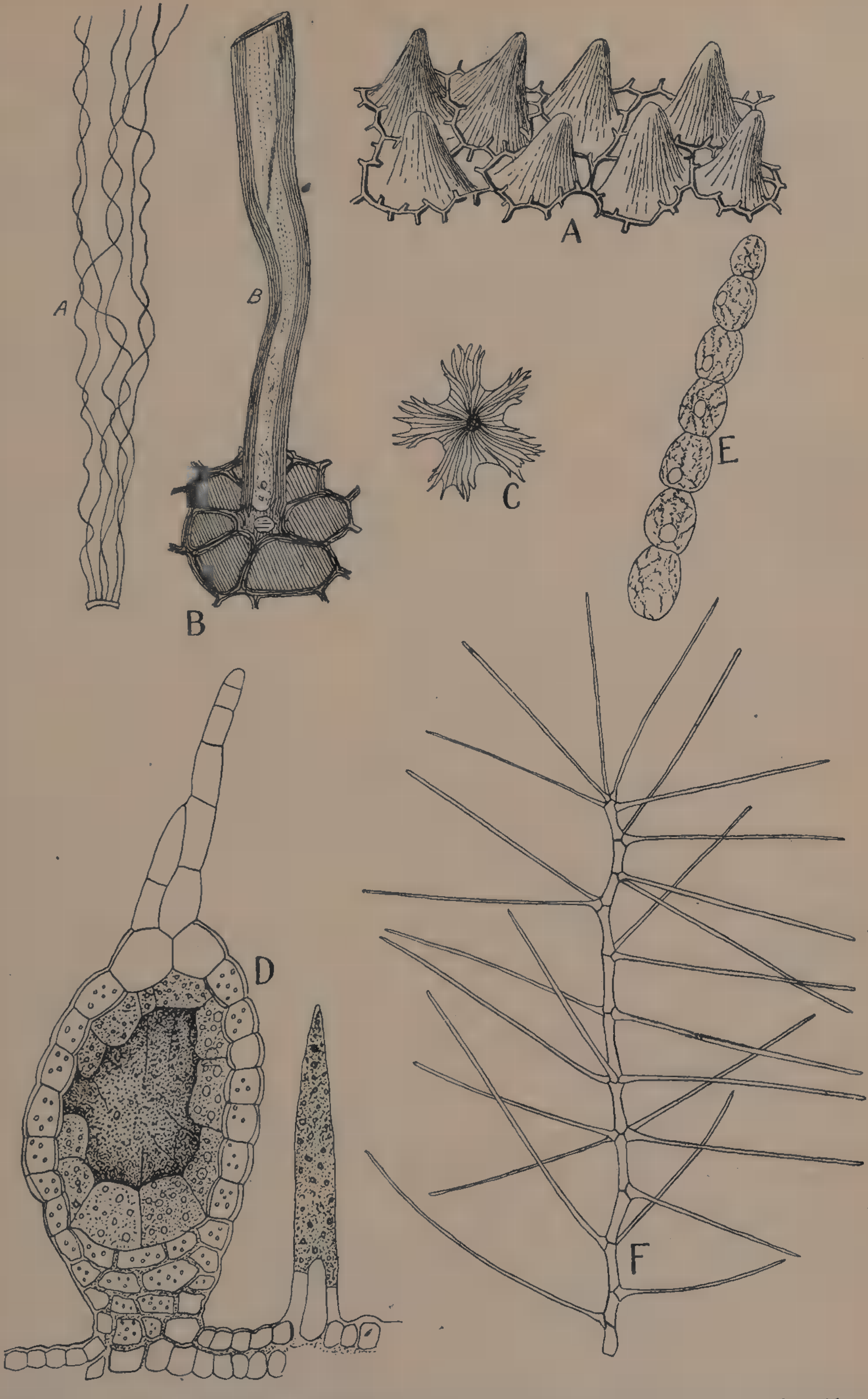

FIG. 325.—A. Portion of the Upper Epidermis of the Petal of *Viola tricolor*. Each cell of the epidermis has grown out in the form of a papilla. B. Hairs from the seed of the cotton plant, *Gossypium herbaceum*. *A*. Hairs magnified about three diameters. *B*. Base of hair and adjacent epidermal cells magnified about 300 diameters. C. Scale-like hair from the upper surface of the leaf of *Hippophæ rhamnoides*. D. Glandular hair from the inflorescence of *Dictamnus fraxinella*. E. Portion of stamen-hair of *Tradescantia virginica*. F. Branched hair from leaf of *Verbascum thapsus*.—(*Figs.* A *and* B *after Strasburger;* C *after Haberlandt;* D *after Rauter*.)

cell unattended by cell division reaches an extreme expression in the hairs covering the seeds of the cotton. These hairs sometimes attain a length of 6 centimeters (Fig. 325, B, *A*). Instead of increasing greatly in length, trichomes may grow into the form of a disk or globe (Fig. 325, D). The formation of trichomes is often attended by cell division. Multicellular trichomes are found, for example, on the filaments of *Tradescantia virginica* and on the leaves of *Verbascum thapsus* (Fig. 325, E, F). The outer walls often have local thickenings, which give to the trichome a barbed or warty appearance. Indeed, the size and form of trichomes are often so characteristic as to give to the pharmacist a means of determining the source of a vegetable drug in the form of a powder.

Trichomes have quite various functions; in some instances they contribute to the efficiency of the epidermis in protecting the underlying tissues against unfavorable meteorological conditions. Root-hairs, which are greatly elongated epidermal cells from the younger portions of roots, and are therefore true trichomes, have an absorptive function. The trichomes on the stems of the hop vine assist in its climbing. The long hairs on the seeds of cotton and of many other plants have the biological function of assisting in the dissemination of the seeds. Glandular hairs secreting the volatile oils which give the characteristic odors to many aromatic plants, such as the cultivated geranium and *Dictamnus fraxinella*, have a secreting function. The hairs on the stinging nettle, *Urtica dioica*, have a protecting function in that they penetrate and inject under the skin of animals which touch them an irritating and poisonous fluid. The base of the hair is much enlarged and contains the irritating secretions (A, Fig. 326). At the tip of the hair is a knob, and just beneath this the very thin walls are silicified, and so quite brittle. When the knob is pressed upon, it breaks off, and the sharp, silicified point (B, Fig. 326) of the broken hair pricks the skin, and at the same time the pressure transmitted to the base of the hair ejects the secretion into the wound. The turgescent condition of the hair must also contribute to the ejection of the fluid.

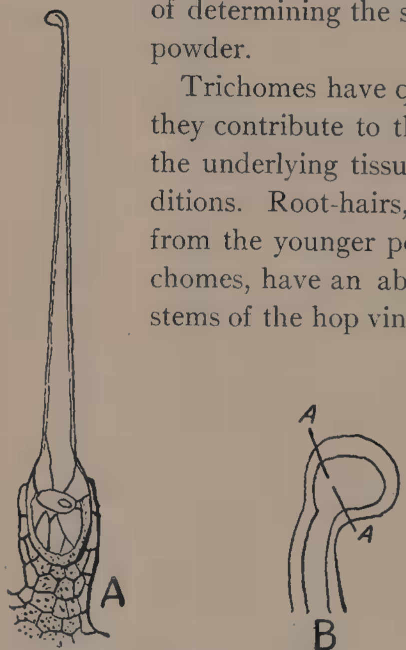

FIG. 326.—A. Stinging hair of *Urtica urens*. B. Apex of stinging hair of *Urtica dioica*, showing line of fracture, *A*, *A*.—(*After Haberlandt*.)

The Stomata.—The cutinized epidermis is so well adapted to prevent the loss of water by transpiration that it at the same time hinders the ingress of the oxygen and carbon dioxide necessary to the life and growth

of the plant. Openings through the epidermis, called stomata, have been provided, however, which admit gases freely into the plant and permit the transpiration of water from the plant, but which are able to close automatically and prevent transpiration when the water-supply is running low. In those leaves which assume a position approximately at right angles to the incident rays of the sun the stomata are more numerous on the under than on the upper side. Those leaves, however, which hang downward or rise nearly perpendicularly, such as those of *Populus monilifera* and of the Gramineæ, have about the same number of stomata on both sides of the leaves. Leaves which remain submerged in water have few or no stomata, while those which float on the surface of water have stomata only on the upper side. The stomata are formed by the division, perpendicular to the surface, of a young epidermal cell, and the subsequent separation of the daughter cells, except at the two ends (Fig. 327). The daughter cells form the guard cells which, by changing their form, are able to draw apart from each other, thus making an opening through the epidermis, or to draw together again and close the opening. An explanation of this action is to be found in the structure and contents of the guard cells. Figure 328 represents the structure of a typical stoma, B in cross-section and A as seen from the surface. The wall of the guard cells which borders the opening will be called the ventral wall, and the side opposite to this the dorsal. The ventral wall has two ridges extending parallel with and near to the upper and lower surfaces. The ventral and dorsal walls are thinner than the upper and lower walls, and the thin dorsal wall is considerably broader than the thin portion of the ventral wall. At *M* is a sort of hinge-joint which facilitates a lateral movement of the guard cells. All of these points of structure have a significance in the opening and closing of the stomata.

In addition to their protoplasts and watery cell-sap the guard cells contain chloroplasts, while other epidermal cells, as a rule, do not. This also has to do with the operation of the stomata. It has been found out by measurements under the microscope that the guard cells are larger when the stomata are open than when they are closed—that is, the guard cells are more turgescent at that time. When the guard cells become more turgescent, the thin dorsal walls swell outward. The thin ventral walls are prevented from stretching to an equal extent because the thin portion here is less extensive, and because of the thick ridges which flank them above and below; the whole cell must accordingly be pulled outward with the stretching of the dorsal wall. Such an action can be easily demonstrated by connecting with the faucet of the water-supply two short pieces of rubber tubing which have been trimmed thin on one

side. The ends of the tubing opposite to the faucet are plugged up and tied together so that the pieces of tubing shall touch each other throughout their extent, the thin sides being turned outward. When the water pressure is turned on, the thin side of the tubing swells out, and the pieces are drawn apart.

The stomata open in the daylight and, as a rule, close at night. They close even in the daytime when the plant begins to feel the loss of water, which, of course, happens when the loss by transpiration is greater than

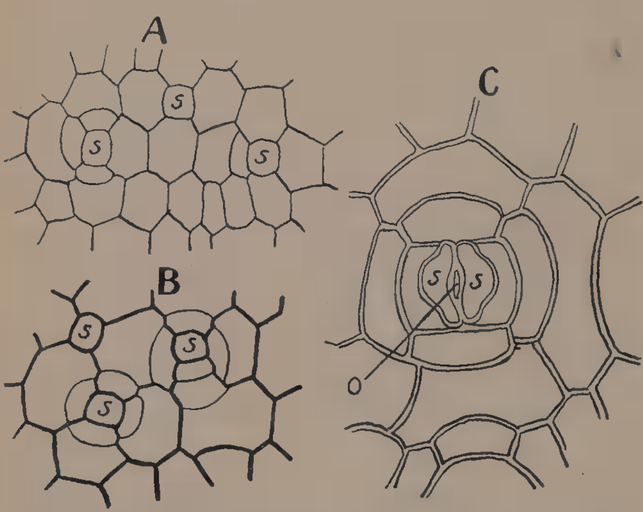

FIG. 327.—Development of the Stomata of the Leaf of *Commelina cœlestis*. A and B. Early Stages. *S*, *S*. The young mother cells of the mature guard cells shown at *S*, *S* in C. At *O* is the opening between the guard cells.—(*After Sachs.*)

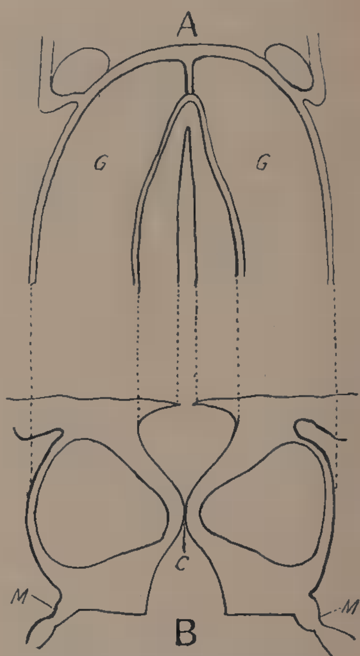

FIG. 328.—Cross and Longitudinal Diagram of a Stoma of *Narcissus biflorus*. A. Half of a surface view of a stoma, and B, a corresponding cross-section. At *C* is the opening between the guard cells, represented here as closed. *G*, *G* represent the guard cells. At *M*, *M* is a sort of hinge-joint which facilitates the movement of the guard cells away from each other as the stoma opens.

the amount absorbed. In the daytime, as will be explained when the leaf is discussed, the chloroplasts manufacture carbohydrates, which become dissolved in the cell-sap and add to its osmotic capacity. In consequence of this water is drawn in from the neighboring cells and the guard cells become stretched and open out, as explained above. In the night-time the carbohydrates are no longer manufactured, because of the withdrawal of the energy of the sunlight; the guard cells lose their excessive turgidity and, by the elasticity of their walls, straighten back against each other and close the opening.

In time of drought, when the supply of water in the plant is limited, the evaporation of water from the surface of the guard cells would prevent them from acquiring the turgidity necessary to open the stomata. The necessity of the guard cells, and their admirable adaptation to the needs of the plant, will be further discussed later with the structure and functions of the leaf.

Cork.—The cells of the epidermis soon lose their power of division, and, as a consequence, the epidermis becomes broken on those stems and roots which continue to increase in thickness through long periods of growth, as is the case with perennial dicotyledons and Coniferæ. In such instances the epidermis is replaced by cork which is formed by the tangential division of the epidermal cells, or, as most frequently happens, by the division of the ground tissue cells which lie immediately beneath the epidermis. The continued tangential division of a layer of

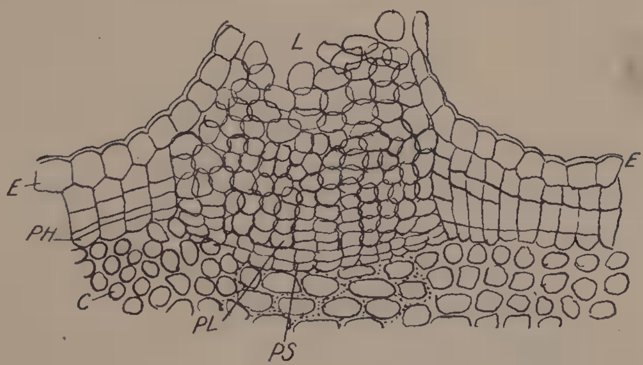

FIG 329.—Cross-section through a Lenticel of *Sambucus nigra*. *E*. Epidermis. *PH*. Phellogen. *L*. Loosely disposed cells of the lenticel. *PL*. Cambium of the lenticel. *PS*. Phelloderm. *C*. Cortical parenchyma containing chlorophyll.—(*After Strasburger.*)

cells formed in this way produces successive layers of cork cells toward the outside and immediately beneath the epidermis.

At least one layer of cells does not change to cork, but retains its power of division and its cellulose walls unchanged, and so constitutes a secondary meristem, which is known as the cork cambium, or *phellogen*. The cork cells are usually brick-shaped and are joined together without intercellular spaces. The walls of the cork cells are suberized, and so rendered practically impervious to water and gases. The cork cells soon lose their protoplasts and cell-sap, and then usually contain only air; but sometimes they contain brownish substances, which appear to be closely related to the tannins. The cork cambium is able to divide radially as well as tangentially, and is thus able to keep pace with the growth in diameter of the organ which is covered by it. The cork may finally replace the epidermis entirely, as in the case of the older branches and trunks of trees. The cork and cork cambium are collectively termed the *periderm*.

The *lenticels* in the cork perform the aërating function of the stomata in the epidermis. They are visible to the naked eye, even before the epidermis is obliterated, as elongated or rounded and usually brownish protuberances. The lenticels are formed by the localized production of rounded and loosely joined cork cells (Fig. 329), which finally break through the tissues which cover them and appear at the surface. Their numerous intercellular spaces fit them for their aërating function. The formation of cork cells in deeper lying tissues will be spoken of later when the structure of stems and roots is discussed.

The Vascular Tissues.—The procambium bundles which are formed from the primordial meristem at a short distance from the growing point (Fig. 321, C) soon undergo radical changes, resulting in the formation of permanent tissues having various physiological functions. The permanent tissues which arise from the procambium bundles are known as the vascular bundles. An understanding of the constitution of a vascular bundle will be best obtained by a description of the steps in its development. The formation of the type of bundle known as collateral, of frequent occurrence in the stems of Phanerogams, will be taken as an example. Several of the cells on the inner side of the procambium bundle —namely, the side next to the center of the stem—become elongated, and also larger in their cross diameters; ring-formed and spiral thickenings are formed on the inner surface of their walls, and the partition walls which separated them, end to end, become broken down, so that a long tube is formed from the original cell-row. After the thickenings on the cell-walls are completed, the protoplasts of the cell-row disappear. The tubes with the annular and spiral thickenings are known as annular and spiral vessels respectively (Fig. 321, *V*, and Fig. 330, *A*, *A′*). There is a continuous line of these vessels extending from the newest formed portions near the growing point of the stem to the newest formed portions near the extremities of the roots. The function of the annular and spiral vessels, and the other types of vessels which are formed later, is to conduct water from the place of its absorption near the extremities of the roots to all parts of the plant. The thickenings on the walls of the vessels tend to prevent the latter from collapsing when subjected to the lateral pressure which must necessarily occur when they and their neighboring cells increase in diameter. If increasing the strength of the vessels were the only problem to be met, this could be more thoroughly done by thickening the entire wall of the vessels; but other conditions must be met. Thick walls would offer resistance to the growth in length which must still take place near the apex where the vessels are first formed, while the spiral and annular thickenings offer no appreciable resistance. Thick walls offer greater resistance to the passage of the water into the vessels at the roots

and out again in other parts of the plant where the water is needed. Economy of material is also a consideration which the struggle for existence has made imperative. The spiral and annular thickenings meet all of these conditions admirably.

On the side of the bundle toward the outside of the stem the procambium cells divide longitudinally, and give rise to a vertical row of cells,

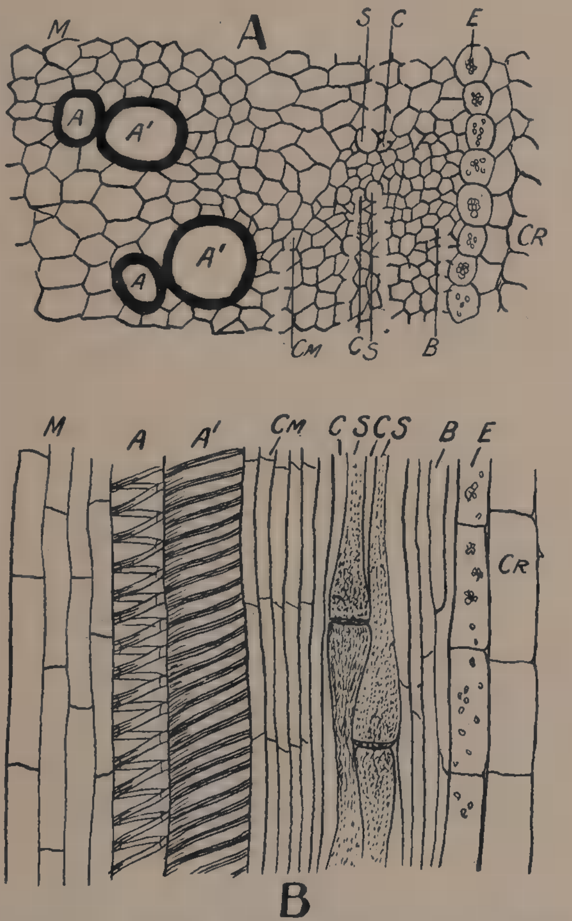

FIG. 330.—Simplified Diagram of Cross- and Longisections of primary Xylem and Phloëm of *Helianthus annuus*. *A*, *A'*, Spiral vessels. *S*. Sieve tubes. *C*. Companion cells. *B*. Incipient bast of the pericycle. *E*. Endodermis. *CR*. Cortex. *M*. Pith. *CM*. Cambium cells.

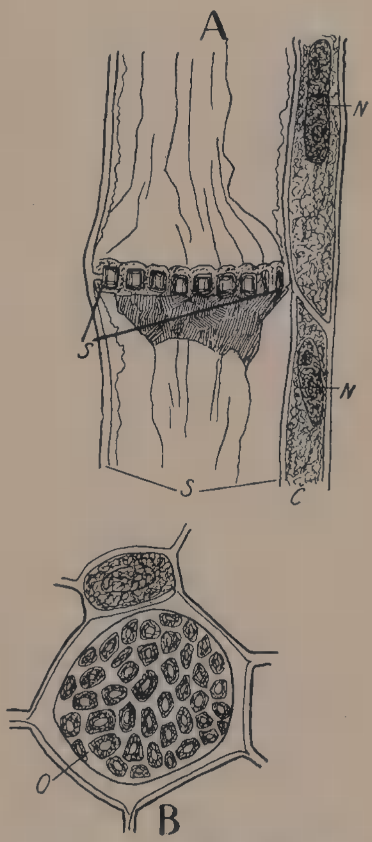

FIG. 331.—A. Longitudinal View of Portion of Sieve Tube and Companion Cell of *Cucurbita pepo*. Lower *S* sieve tube. *C*. Companion cell. *S*. Sieve plate. *N*. Nuclei of companion cells. B. Sieve Tube and Companion Cell in Cross-section. *O*. Perforations in sieve plate.—(*After Strasburger*.)

which again divide longitudinally to form a double longitudinal row known later as the sieve tubes and companion cells. The cells which are to become the sieve tubes elongate and increase in their cross-diameters, and the walls which separate them, end to end, become thickened in such a way as to leave thin places in the form of pits (Fig. 330, in *S*, and Fig. 331). These cells finally lose their nuclei. The companion cells elon-

gate, but increase in their cross-diameters relatively little. The nuclei of the companion cells persist and are probably able to exert an influence on the protoplasts of the sieve tubes, with which they are in immediate contact.

In many plants certain of the procambium cells on the side next to the vessels and on the side with the sieve tubes divide transversely, and produce vertical rows of shorter cells which remain thin-walled and retain their protoplasts; these are known as the wood and bast parenchyma respectively. Certain of the procambium cells in the middle of the bundle remain undifferentiated and retain their power of division. These are known as the cambium cells (Fig. 330, *Cm*). These tissues which are thus differentiated from the procambium constitute what is known as the primary *vascular bundle*, in which the cambium divides the inner or xylem portion from the outer or phloëm portion. The annular and spiral vessels and parenchyma of the xylem are called the protoxylem, and the first sieve tubes and companion cells and bast parenchyma the protophloëm.

The cambium retains the power to divide longitudinally by the formation of both tangential and radial walls. The cells which are thus cut off from the cambium become gradually transformed into the xylem elements toward the inside and the phloëm elements toward the outside. The division of the cambium by tangential walls would add to the radial diameters of the two portions of the bundles, while the tangential diameters of the bundles would be increased by the formation of radial walls in the cambium. The xylem and phloëm portions of the bundles would thus come to be, in cross-section, more or less wedge-shaped (Figs. 344 and 348), with the apex of the xylem portion pointing toward the center of the stem and the apex of the phloëm portion pointing toward the periphery. The type of vascular bundle just described is known as the open, collateral bundle.

In monocotyledons and some dicotyledons, such as the Nymphæaceæ, the whole of the procambium passes over into permanent tissues and no cambium is present. Such a bundle does not, therefore, continue to increase in thickness, and is called a closed bundle. *Zea mais* affords a good illustration of this type of bundle (Fig. 332).

In the Cucurbitaceæ, Convolvulaceæ, Asclepiadaceæ, and several other families of plants a second phloëm portion is developed on the pith side of the xylem, forming what are known as bicollateral bundles.

In the stems of ferns and of many water plants (hippuris, myriophyllum, ceratophyllum, etc.), the phloëm portion of the bundle surrounds the xylem, forming a concentric bundle. Less frequently, as in the case of the rhizomes of some monocotyledons, the phloëm portion is surrounded by the xylem portion (Fig. 333).

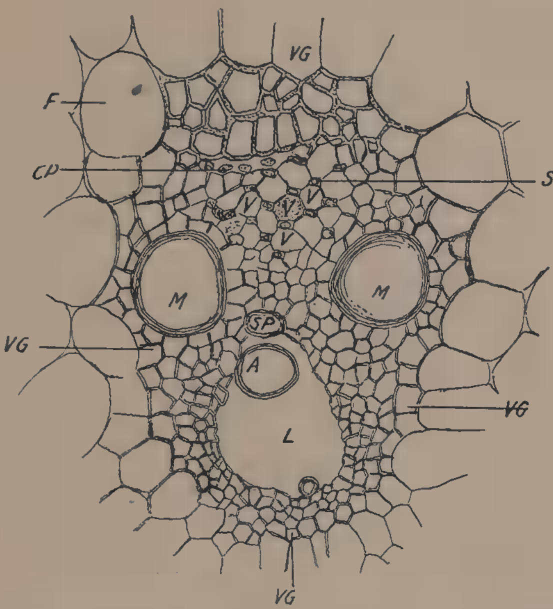

FIG. 332.—Closed Bundle of Stem of *Zea Mays*. *VG*. Bundle sheath. *L*. Intercellular space. *A*. Ring from an annular tracheal tube. *SP*. Spiral tracheal tube. *M*. Pitted vessels. *V*. Sieve tubes. *S*. Companion cells. *CP*. Crushed primary sieve tubes. *F*. Thin-walled parenchyma of the ground or fundamental tissue.—(*After Strasburger*.)

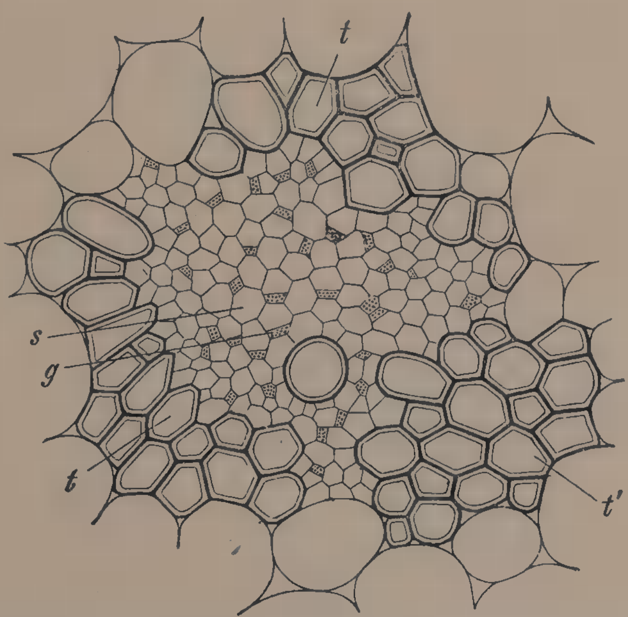

FIG. 333.—Transverse Section of a Concentric Bundle from the Rhizome of *Iris*. Xylem surrounding the Phloëm. *t*. Tracheæ. *t'*. Protoxylem. *s*. Sieve tubes. *g*. Companion cells of the internal phloëm portion.—(*After Vines*.)

In roots the xylem and phloëm portions alternate with each other, as shown by figure 334, and so form radial vascular bundles.

The xylem portion of the bundles carries water from the roots to the leaves, and the phloëm portion carries food materials which have been manufactured in the plant, chiefly in the leaves. It is obvious that such a separation of highways as is found in the vascular bundles greatly facilitates the transportation of materials; for, while the course of the water is chiefly upward from the roots, the course of the elaborated food materials must be in part downward to the growing roots and other growing regions of the plant lying below the source of elaborated food materials in the leaves. If the water and plastic materials were obliged to pass through the same tissues in their opposite courses, it is evident that the movement of both would be seriously hindered.

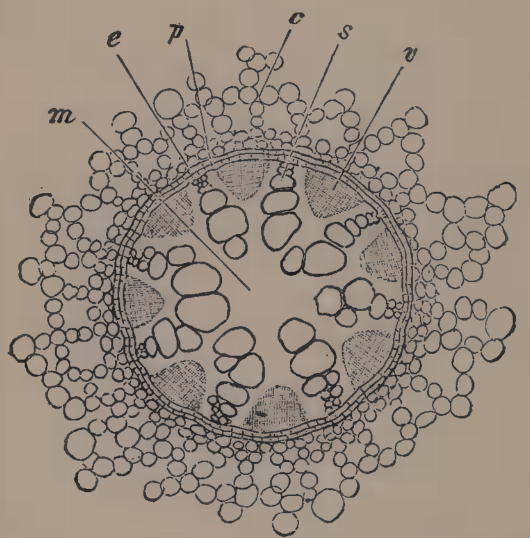

FIG. 334.—Transverse Section of Central Part of the root of *Acorus calamus*. *c*. Cortex. *e*. Endodermis. *p*. Pericycle. *s*. Primary xylem or wood-bundles, with small spiral vessels of the protoxylem externally. *v*. Phloëm portion of vascular bundles. *m*. Pith.—(*After Strasburger*.)

Early in the spring a portion of the reserve materials which are becoming soluble infiltrates into the tracheal tubes, and is carried upward by the ascending currents of water; but later, when the reserve materials become depleted and the leaves begin their activities, the water and plastic materials become more restricted to their separate highways, as above described.

As will be learned later, the stomata in the leaves should remain open during the hours of daylight, in order that sufficient carbon dioxide gas may enter the leaves for the manufacture of the amount of carbohydrate necessary for the vigorous growth of the plant. When the stomata are open, however, the amount of water evaporated through them is quite considerable, and the water-supply rising through the stem into the leaves must be correspondingly great. It is evident that to attempt the transport of materials downward through the same channels in which the water is rising would prove disastrous to the economy of the plant, since all plastic materials—that is, food materials—must, during transport, be in solution in the cell-sap, and if poured into the same channels with the ascending water, would mix with it and be carried along by it. The

radial arrangement of the bundles in the root permits the water which has been absorbed from the soil to pass immediately into the xylem without first having to traverse the phloëm, as would necessarily be the case if the arrangement of the bundles in the roots were the same as in most stems where the phloëm stands in front of the xylem.

Whatever position and arrangement the vascular bundles may have, they are always an uninterrupted highway for the transport of materials between all parts of the plant, from the finest rootlets in the soil to the remotest leaves and floral organs.

The course which the vascular bundles take through the plant body varies in different plants. In most roots the bundles pursue a straight course, running parallel with each other throughout their extent. In the stems of most ferns the bundles anastomose with each other in the form of a cylindrical network, as shown by figure 335. The leaves are inserted over the interstices, *L*, and the lateral branches which arise at the borders of the interstices pass into the leaves. In most dicotyledons and some monocotyledons the bundles run, for the most part, parallel with each other. Some of the bundles pass outward into the leaves, and others terminate near the growing apex of the stem; the former are called common bundles,—common to both leaf and stem,—and the latter are known as cauline bundles. In *Iberis amara*, where the leaves have an alternate arrangement, the bundles pass downward from the leaves, and join without branching, with those from leaves of lower nodes, and the combined bundle thus formed unites with bundles from still lower leaves, etc. (Fig. 336). In *Clematis viticella*, having opposite leaves, three bundles pass from each leaf down into the stem; the median bundle divides, forming two branches, each of which unites with a lateral bundle of the two opposite leaves of the next lower node; and the lateral bundles of each leaf also unite with the lateral bundles of the next lower node, as shown in figure 337. In palms and most monocotyledons many bundles pass from the broad bases of the leaves into the stem. In palms the bundles pass rather sharply inward toward the center of the stem, and then downward and gradually outward until they unite with bundles from leaves several internodes beneath, as shown in figure 338. In this type the several bundles from a leaf do not run inward to equal depths; the stronger bundles from the middle of the leaf pass farther toward the center of the stem, while the weaker bundles near the borders of the leaf take a more direct course downward through the stem. Accordingly, a cross-section of such a stem shows the larger bundles toward the center, and the smaller bundles toward the periphery (Fig. 339).

The course of bundles in leaves varies in different plants. In most monocotyledons many bundles enter the leaf from the stem, and pursue

direct and nearly parallel courses to the apex. These main bundles send off smaller offshoots laterally, which may fuse together or else end free in the parenchyma of the leaf.

The terminations of the bundles in the leaf are very simple in their structure (Fig. 340). They consist usually of very delicate tracheids with spiral or reticulated thickenings, which are surrounded, as a rule, by thin-walled parenchyma cells, usually destitute of chlorophyll, and uniting directly with the chlorophyll-bearing parenchyma cells. As will be shown later, the chlorophyll-bearing parenchyma cells of the leaf have for their chief function the manufacture of food-stuffs for the plant. The tracheids at the ends of the bundles in the leaves are, then, the ultimate branches of the water highways which deliver over to the assimilating cells of the leaves the water and mineral substances from the soil, while the return current containing the finished, or partly finished, product begins in the parenchyma cells bordering the tracheids.

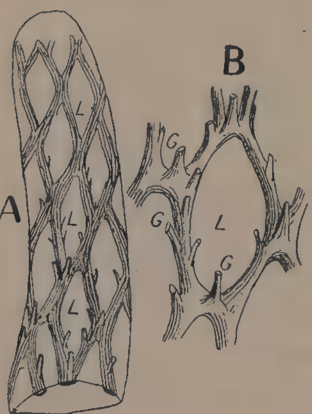

FIG. 335.—A. Cylindrical Network of Vascular Bundles in the Stem of *Aspidium Filix-mas*. B. A portion of the same more highly magnified. At *L* are the interstices over which the leaves are inserted; at *G* are branches passing into the leaves from the main vascular bundles.

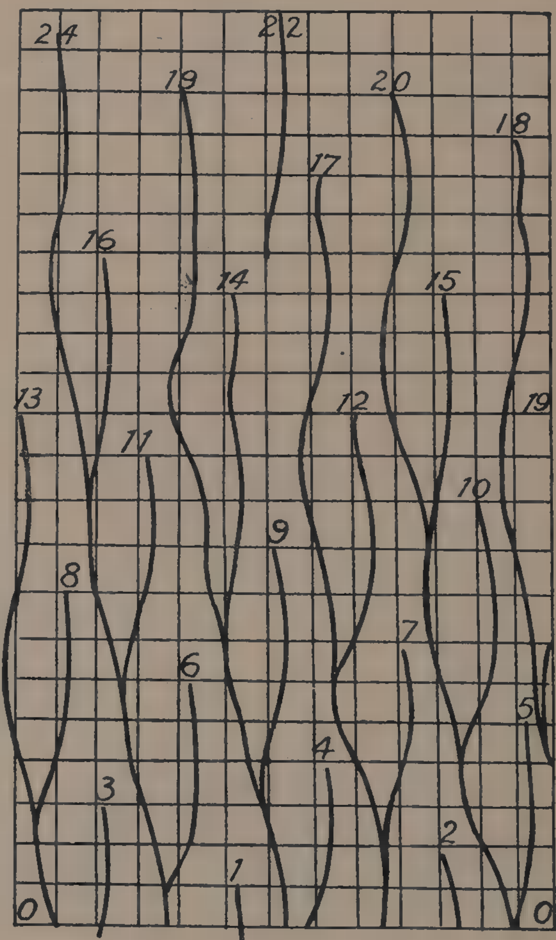

FIG. 336.—Diagram Showing the Course of the Bundles in a Young Foliage Shoot of *Iberis amara*. The diagram is made to show the ring of bundles spread out in a vertical plane. The figures indicate the successive bundles of the leaf-trace at their point of exit from the stem into the leaf.—(*After Nägeli.*)

Relation of the Vascular Bundles to the Increase in Thickness of Plant Members.—Stems and roots may increase in thickness for a short distance back from the vegetative point—that is, from the primordial meristem—by increase in both radial and tangential diameters of the cells of the primary meristems. In most monocotyledons the primary meristems soon become permanent tissues, and growth in thickness then ceases. In the dicotyledons and gymnosperms, however, increase in thickness may be continued by additions to the bundles and medullary rays through the ac-

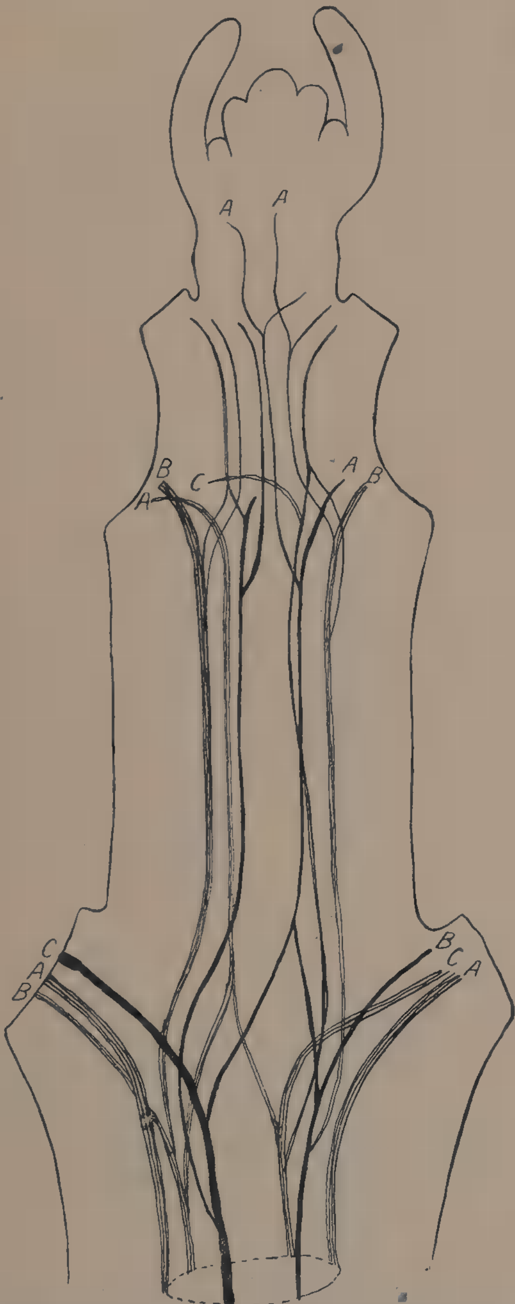

Fig. 337.—Diagram Showing the Course of Bundles in a Branch of *Clematis viticella*. Median bundles from the leaves are marked *A*, lateral bundles *B* and *C*. Description in the text.—(*After Nägeli.*)

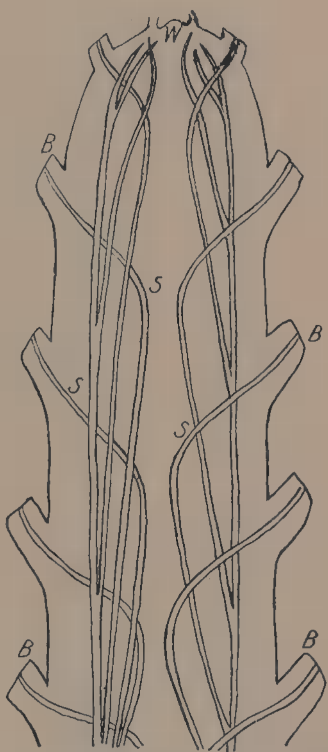

Fig. 338.—Simplified Diagram Showing the Course of the Bundles in the Palm Type. *B*. Base of the leaf. *W*. Vegetative point. *S*. Bundles from near the center of the leaf.—(*After Sachs.*)

tivity of more or less permanent cambium regions; and this is also essentially true of certain monocotyledons, such as dracæna and yucca,

where a zone of ground tissue outside of the region of the first procambium bundles gives rise to a secondary meristem which may increase the diameter of its member indefinitely (Fig. 341). New bundles are then successively formed in the tissues produced by the meristematic zone.

The Fundamental or Ground Tissue.—The fundamental tissue is produced by the division of the cells of the ground meristem, so that where growth in length has ceased, the fundamental tissue has succeeded to the ground meristem. Remove the epidermis and the vascular bun-

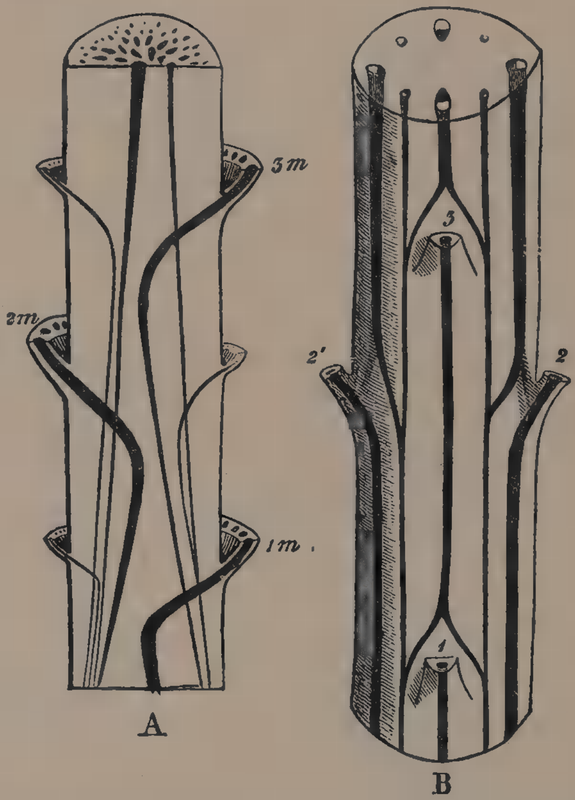

FIG. 339.—A. Diagram of Course of Vascular Bundles as Seen in Longitudinal Section of Palm Stem. 1*m*, 2*m*, 3*m*. Bundles from the median portions of the leaves. B. External view and transverse section of Cerastium. The leaves are represented cut off at 1, 2, 2′, 3. The bundle proceeding from each leaf divides into two above the leaf immediately below it, and the branches of all the bundles unite to form the four thin bundles which alternate with the thicker ones.—(*After Vines.*)

dles, and the remaining structure is ground or fundamental tissue (Fig. 321). When the fundamental tissue is first formed, its cells have thin cellulose walls, but in some instances certain groups of cells become meristematic and produce secondary procambium, which finally develops into thick-walled bast fibers. Frequently the cells of a zone just beneath the epidermis become thickened at the angles, and constitute a strengthening tissue known as the *collenchyma* (Fig. 342); still other cells of the fundamental tissue may become very thick-walled and lignified, forming

the *stone cells*, which contribute to the hardness of their member. The stones of stone fruits are formed by such cells (Fig. 296). Stone cells cause the grittiness in the fruit of the pear and quince, and they also contribute to the hardness of the bark of many plants.

In some Compositæ, Campanulaceæ, Papaveraceæ, etc., certain cells of the fundamental tissue fuse together in the form of a much branched system containing latex, or milk. Such cell fusions are designated as laticiferous vessels (Fig. 343). The laticiferous vessels of the Euphorbiaceæ, Asclepiadaceæ, Apocynaceæ, and Urticaceæ have a mode of

FIG. 340.—Termination of a Vascular Bundle in a Leaf. *A*. Thin-walled parenchyma cells, which are destitute of chlorophyll. *T*. Tracheid ending free in the parenchyma of the leaf. *B*. Chlorophyll-bearing parenchyma cells.—(*After Frank.*)

origin different from that described above; for, instead of consisting of cell fusions, they are single cells, very much branched and elongated. They are even to be distinguished in the embryo, with the development of which into the mature plant they keep pace by continued elongation and repeated branching. The latex consists of a watery fluid holding various substances in solution, such as salts of different kinds, alkaloids, tannins, sugar, mucilages, and proteid substances. Besides the substances in solution, others, such as gums, resins, caoutchouc, oils, and starch-grains may be held in suspension in the form of very fine particles or droplets.

The cells of the fundamental tissue in general, however, continue to have thin cellulose walls and to be isodiametric or but little elongated.

The vascular bundles divide the fundamental tissue into two regions—an inner medullary and an outer cortical region (Figs. 344 and 348). The medullary portion constitutes the pith, the cortical portion forms a large part of the so-called bark, while those portions which connect the

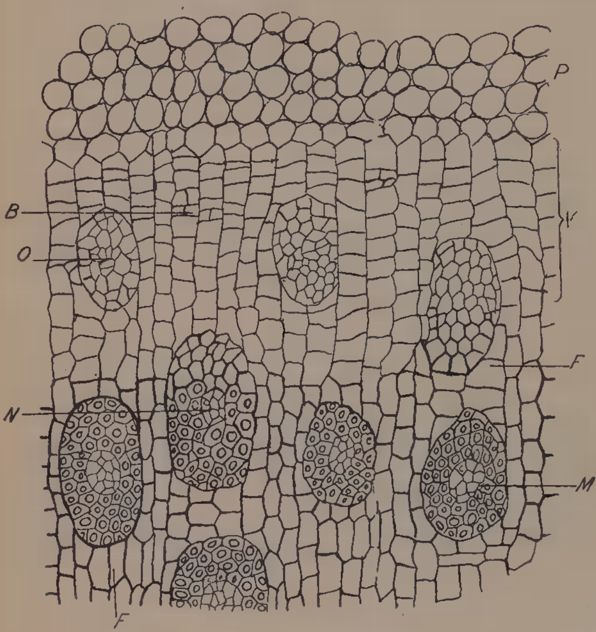

FIG. 341.—Portion of a Cross-section through the Stem of *Dracæna marginata*. *P*. Cortical parenchyma. *V*. Meristematic zone, by the activity of which the stem increases in thickness, and in which new vascular bundles arise. *M*. Mature vascular bundle. *N*. Nearly mature vascular bundle. *O*. Newly-formed procambium bundle, from which a vascular bundle is to become differentiated. *B*. Beginning of a procambium bundle by the rapid division of the cells of the meristematic zone. *F*. Parenchyma cells of the fundamental or ground tissue.—(*After Haberlandt.*)

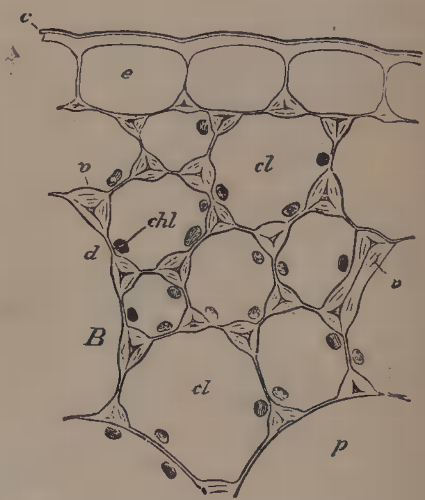

FIG. 342.—Transverse Section of Part of Leaf-stalk of a Begonia. *e*. Epidermis. *c*. Cuticle. *B*. Collenchyma, with walls thickened at the angles *v*. *chl*. Chloroplasts.—(*After Vines.*)

medullary and cortical regions are known as the *medullary rays* (Fig. 344).

In many cases the pith cells do not grow in length as fast as the surrounding tissues, and so become torn and finally practically obliterated. They frequently lose their protoplasts at an early age, and then they contain air only. In Juncus and Scirpus, for example, the pith cells grow into the form of a star and cause large intercellular spaces in this way.

The cells of the cortex retain their protoplasts indefinitely, as a rule, and serve the purpose of conducting and storing carbohydrates chiefly, and proteid substances to a certain extent. The cells of the medullary

rays have essentially the same structure as the cortical cells; they are highways of communication between the cortex and pith; and, after the bundles have attained to considerable size through secondary increase in thickness caused by the activity of the cambium, the medullary rays be-

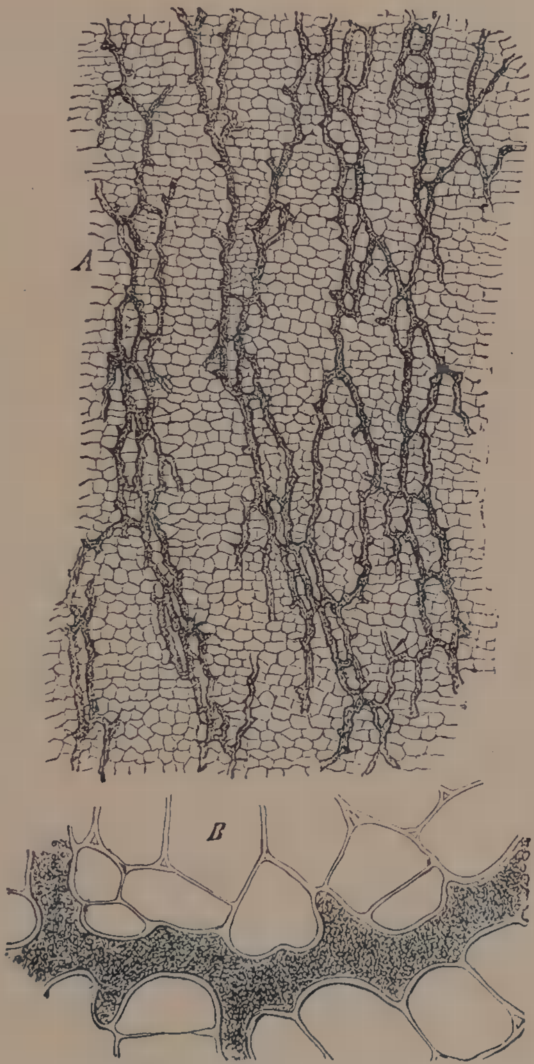

FIG. 343.—Laticiferous Vessels from the Cortex of the Root of *Scorzonera hispanica*. *A*. Slightly magnified. *B*. A small portion more highly magnified.—(*After Sachs*.)

come very necessary for the interchange of materials between the bundles and the cortex.

Before winter sets in the cells of the cortex, medullary rays, and pith cells adjacent to the bundles become gorged with carbohydrates and proteid substances, which are to be used in building up new tissues when growth is resumed in the spring.

Bulbs, tubers, fleshy roots, and fruits consist, for the most part, of fundamental tissue.

The thin places in the form of pits which frequently occur in the cells of the fundamental tissue facilitate the transport of materials by osmosis. As will be shown later, it is the fundamental tissues in leaves which bear the chloroplasts and carry on the assimilating function.

CHAPTER VII.—SECONDARY INCREASE IN THICKNESS.

After the primary meristems have gone over into permanent tissues, and the cells have attained to their full size, no further increase in thickness can take place without the formation of a secondary meristem, unless, as is the case with most dicotyledons and gymnosperms, some portion of a primary meristem continues to be meristematic. In the case of most monocotyledons, such as the grasses, any secondary procambiums which may arise from the fundamental tissues soon pass over into permanent tissues, and increase in thickness is due almost exclusively to the enlargement of cells which have been derived directly from the primary meristems (see p. 579).

In most dicotyledons and gymnosperms, however, a portion of each procambium bundle remains meristematic and constitutes a fascicular cambium (Fig. 344, *CM* in B), while certain of the cells of the ground tissue between the bundles, in line with the cambium cells of the bundles, become meristematic and form an interfascicular cambium (Fig. 344, *IC* in B), which, with the fascicular cambium, constitutes an unbroken meristematic zone. The cambium cells are elongated in the direction of the long axis of the stem or root, are somewhat pointed at the ends, and their tangential diameter is greater than their radial (Fig. 345). They, of course, retain their protoplasts, and their original cellulose walls do not become materially altered. The cambium cells have the power of division by tangential, radial, and cross walls. When tangential walls are formed, one of the daughter cells remains meristematic while the other may directly, or after undergoing one or more divisions, go over into the permanent condition. More frequently, when a cambium cell divides, the outer of the daughter cells remains meristematic, and then the xylem portion of the bundle is increased by the addition of the inner daughter cell or its descendants. Less frequently, the inner

daughter cell remains meristematic, while the outer daughter cell is added to the phloëm portion of the bundle; thus, it happens that the xylem is increased more rapidly than the phloëm (compare A, B, and C of Fig. 344) The daughter cells of the cambium may grow to be any of the elements of the xylem or phloëm. On the xylem side the daughter cells of the cambium may (1) enlarge in both radial and tangential diameters,

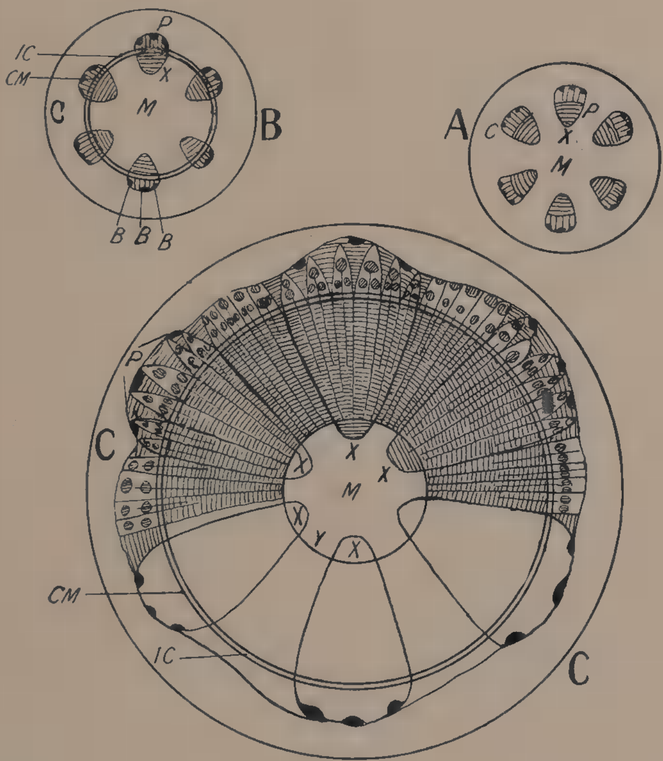

FIG. 344.—Diagrammatic Representation of increase in Thickness of a Dicotyledonous Stem. A. Section near the apex of stem where the procambium strands have become differentiated into protoxylem (X) and protophloëm (P); M, fundamental tissue of the medulla or pith; C, ground meristem of the cortex. B. Section lower in the stem than A. The fascicular cambium has been formed, as shown at CM, and the interfascicular cambium at IC; B, B, B, bast fibers of the phloëm. In A and B the ground tissue between the vascular bundles constitutes the primary medullary rays. C. Cross-section of still lower and older portion of stem, showing increase in thickness due to the activity of the cambium. The inner circle Y represents the original position of the cambium ring when first formed, as in B; at X is the original protoxylem; between X and the present cambium zone CM is the secondary xylem produced by the activity of the cambium; both primary and secondary phloëm occur just outside the present cambium, at P. It is difficult to distinguish between the protophloëm and secondary phloëm, but the former occupies the most exterior portion. The black radial lines represent the medullary rays, the primary medullary rays having become very much narrowed by the interpolation of an interfascicular xylem and phloëm, due to the activity of the interfascicular cambium.—(*After Sachs.*)

elongate, their tangential and radial walls become thickened irregularly and lignified, so that they have a pitted or reticulated appearance, their cross-walls become dissolved, so that a vertical row of cells now becomes fused in the form of a long tube, thus giving rise to *tracheal tubes* (Fig. 345, *t*, *t'*); (2) they may enlarge somewhat in their radial and tangential diameters, greatly elongate in the direction of their long axis, so that

their ends glide past each other, while the walls become much thickened and lignified, forming *wood fibers*, the protoplasts of which finally disappear (Fig. 345, *h*); (3) they may increase considerably in both radial and tangential diameters, elongate more or less, their walls become irregularly thickened and lignified, forming *tracheids* (Fig. 350), the protoplasts of

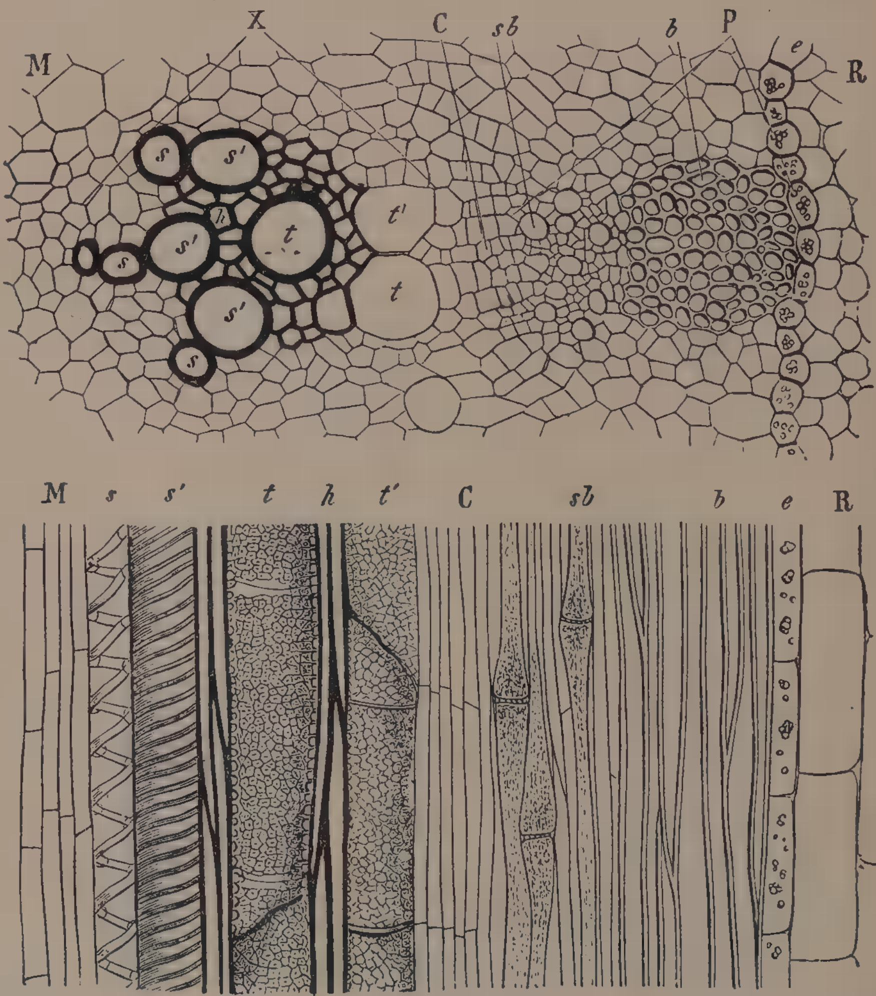

FIG. 345.—Simplified Diagram of Cross- and Longisections of the Stem of *Helianthus annuus* after Secondary Increase in Thickness Has Begun. *s*, *s'*. Spiral vessels of the protoxylem. *t*, *t'*. Pitted vessels of the secondary xylem. *C*. Cambium. *sb*. Sieve tubes. *b*. Bast fibers of the pericycle. *e*. Endoderm. *R*. Cortex. *M*. Pith. *X*. Xylem. *P*. Phloëm. *h*. Wood-fibers. Compare this figure with figure 330, which represents an earlier stage, before the cambium has taken part in increase in thickness.

which finally disappear; (4) they may become divided by cross-walls into a vertical row of cells, whose walls remain, as a rule, relatively thin; but may become lignified, forming *xylem* or *wood parenchyma* (Fig. 349), the protoplasts of which in perennial plants may persist for many years; (5) as the vascular bundles become larger certain of the daughter cells of the cambium may enlarge in all diameters, but chiefly in the radial,

their walls thickening irregularly and forming pits, or remaining relatively thin and retaining their cellulose character for a considerable period, forming *medullary rays* (compare B and C of Fig. 344). The formation of new medullary rays may begin at various distances from the center of the stem, as shown in C of figure 344; thus, it happens that while the primary medullary rays extend from the cortex to the pith, those which are formed later penetrate the xylem to successively less distances. None of the medullary rays extend very far in a longitudinal direction, and they are therefore particularly fitted for the conduction of materials in a radial direction between the cortex, xylem, and pith. The limited extent of the medullary rays longitudinally is shown by figure 346.

By the activity of the interfascicular cambium the same sorts of tissues as those formed from the cambium are interpolated between the primary vascular bundles (Fig. 344, C).

The chief function of the tracheal tubes is the conduction of water. The wood fibers are interlaced to form a strengthening tissue, and it is to them that the great strength of our woody plants is for the most part due. The tracheids serve both for the conduction of water and for giving strength. This double function of the tracheids receives an extreme expression in the wood of the pine, where tracheids in the form of wood fibers take the place both of wood fibers and tracheal tubes.

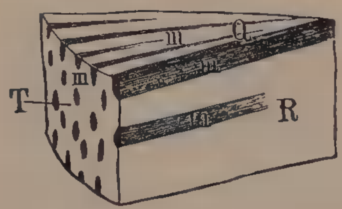

FIG. 346.—Diagrammatic Representation of the Course of the Medullary Rays in a Segment of a Tree Trunk. Q. Horizontal surface. R. Radial surface. T. Tangential or external surface. The shaded bands (*m*, *m*) are the medullary rays.—(*After Vines.*)

On the phloëm side of the bundle the daughter cells of the cambium develop into sieve tubes and companion cells, phloëm parenchyma, and bast fibers. The sieve tubes and companion cells have been formed by the longitudinal division of a common mother cell, which in its turn was a daughter cell from the cambium. The sieve tubes and companion cells are, therefore, in contact with each other. The longitudinal rows of cells which are to form the sieve tubes elongate somewhat and enlarge in their cross-diameters,—that is, radially and tangentially,—the end walls which separate them from each other become thickened irregularly, leaving thin places in the form of pits, which eventually become dissolved away, so that there is continuity of the protoplasmic contents from cell to cell (Figs. 331 and 345). The walls of the sieve tubes remain thin and retain their cellulose character, and the nuclei disappear, while the other structures of the protoplasts persist. The companion cells do not enlarge much in their cross diameter; their walls remain thin, the cellu-

lose character of the walls does not become materially altered, and the protoplasts persist. It seems quite likely that the nuclei of the companion cells are able to extend their influence to the protoplasts of the sieve tubes. There are thin places in the walls between the sieve tubes and companion cells, which probably facilitate the transmission of stimuli from the nuclei, and which assist in the interchange of materials. The contents of the sieve tubes are rich in proteids.

The phloëm parenchyma is formed from the cambium in the same manner as the xylem parenchyma; the cell-walls remain thin and retain their cellulose character. The contents of the phloëm parenchyma are likewise rich in proteid substances.

The bast fibers, which may be direct descendants of the cambium or

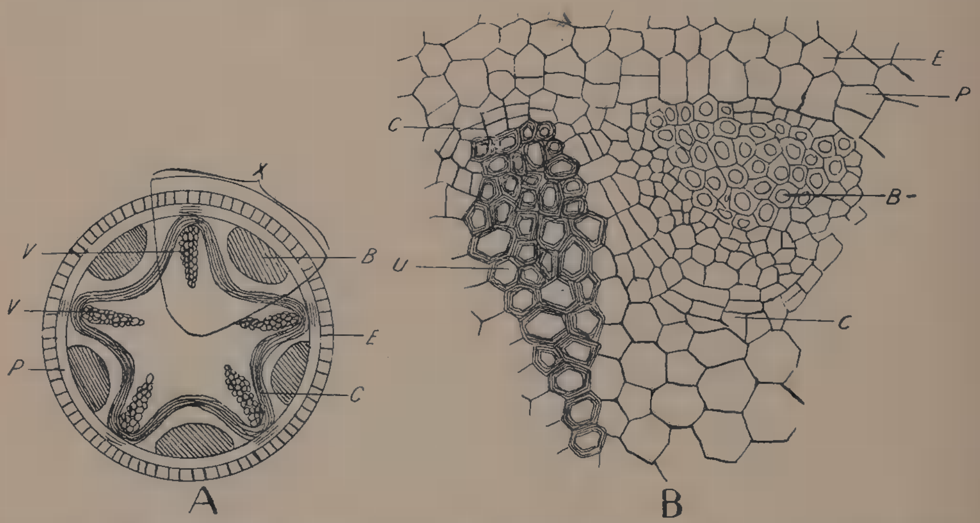

FIG. 347.—Diagrammatic Representation of a Cross-section through the Group of Vascular Bundles of Stele of the Main Root of *Vicia faba* after Growth in Thickness has Begun. *X* demarks a vascular bundle, *V*, *V*, being the xylem and *B* the phloëm portion; *C* is the zone of cambium, *P* the pericambium, and *E* the endodermis. B represents that portion demarked by *X*, very much enlarged; *U* is the xylem. The remaining letters represent the same tissues as in A.—(*After Haberlandt.*)

of a secondary meristem produced by the increasing tissue of the cortex, are formed in the same manner as the wood fibers; their walls become thickened, and frequently, but not always, lignified, and they finally lose their protoplasts. As in the case of the wood fibers, during the process of elongation the ends of the bast fibers glide past each other, and so become firmly spliced together. The bast fibers contribute strength and elasticity to the plant. In many instances the elasticity of the bast fibers nearly equals, and in the case of *Nolina recurvata* slightly exceeds, that of German steel.

It seems that the phloëm, because of the abundance of proteid materials in its cells, and of its proximity to the cambium, has the function of supplying the latter with the materials for its rapid division; and it

also appears to serve the purpose of rapidly conducting plastic materials, and chiefly proteids, to all parts of the plant as needed.

While secondary increase in thickness is brought about by additions mainly to the xylem, and to a less extent to the phloëm, through the activity of the cambium the fundamental tissues may also take part. It has already been stated that the cork cambium or phellogen is frequently produced by the division of the cells of the fundamental tissues which lie immediately beneath the epidermis, and by the activity of the phellogen the thickness of the member may be considerably increased. Other cells of the fundamental tissue lying between the epidermis and the phloëm may give rise to phellogen, by the activity of which the member is temporarily increased in thickness, but the final effect of which is that tissues external to the phellogen become shut off from the circulation of water and other food supplies, die, and finally slough off.

The increase in thickness of roots proceeds in essentially the same manner as in stems. A cambium ring is formed from the cells of the fundamental tissues just outside the xylem and immediately within the phloëm bundles (Fig. 347), and by the activity of this cambium the xylem and phloem elements are increased as in the case of stems, xylem being formed inside the original phloëm bundles, and in some cases, but not frequently, phloëm outside the original xylem.

Rings of Annual Growth.—In most dicotyledons and gymnosperms definite rings of annual growth can be made out in the xylem (Fig. 348). This is due to the fact that the xylem elements formed during the first period of growth in the spring differ in certain respects from those formed later in the season. When growth begins in the spring, the plant has need, first of all, of a larger number of tracheal tubes or large tracheids to carry water to the leaves, which are produced in greater number each year as the crown of leaf-bearing branches increases. Accordingly, in the spring growth large tracheal tubes preponderate (Fig. 349), or large and thin-walled tracheids in the case of the Coniferæ (Fig. 350). After the means for conducting an abundance of water has been provided for in this way, the formation of strengthening elements—namely, of thick-walled wood-fibers and smaller and stronger tracheal tubes and tracheids—predominates. A ring of annual growth consists, then, of tissues with large cell-cavities and relatively thin walls formed in the spring and early summer, and of tissues with smaller cell-cavities and thicker walls formed during the later period of growth. The advantage to the plant given by this difference in the character of the year's growth is evident. It is clear that the water-conducting elements should first be formed, and that when these have been sufficiently provided, more specifically strengthening elements should next be formed. It is, however, impossible at present

to point to the direct chemical and physical causes of this difference, for variations in the turgidity of the cells and differences in the amount of

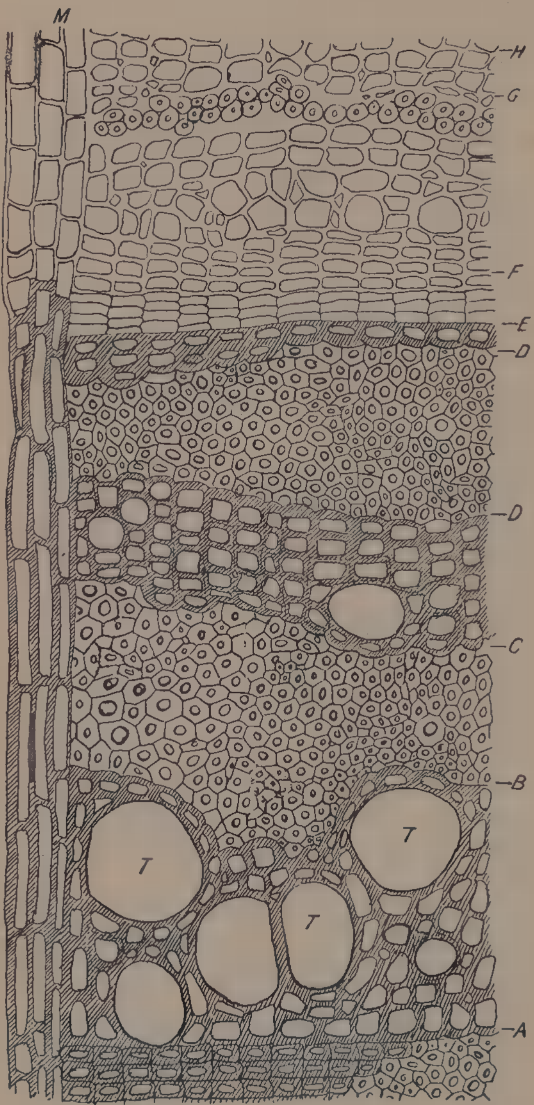

FIG. 349.—Part of a Cross-section through Branch of *Cytisus loburnum*. (The branch was cut from the tree at the end of October.) From *A* to *E* the last annual ring of wood; from *A* to *B* the spring growth with large tracheal tubes (*T*, *T*, *T*); between *B* and *C* and *D* and *D* are wood-fibers; between *C* and *D* and *D* and *E*, wood parenchyma; from *E* to *F*, cambium; *F* to *G*, phloëm portion; *G* to *H*, cortical parenchyma. *M*. Medullary ray. Below *A* the last wood-fibers and wood parenchyma formed the previous year.—(*After Haberlandt.*)

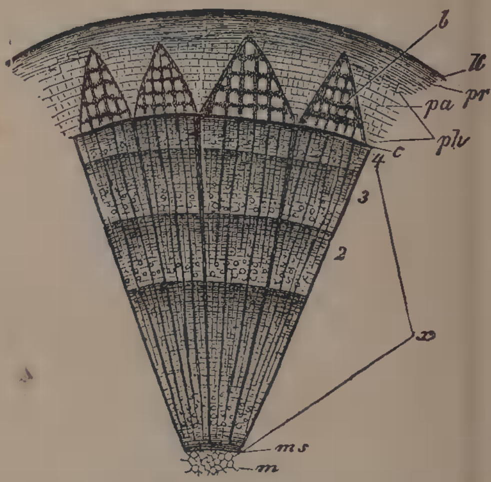

FIG. 348.—Part of a Transverse Section of a Twig of the Lime, Four Years Old. *m*. Pith. *ms*. Medullary sheath. *x*. Secondary wood. *Ph*. Phloëm. 2, 3, 4. Annual rings. *c*. Cambium. *pa*. Dilated outer ends of medullary rays. *b*. Bast. *pr*. Primary cortex. *k*. Cork.—(*After Vines.*)

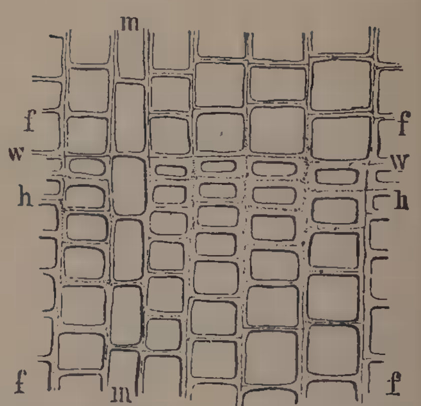

FIG. 350.—Portion of a Cross-section through the Wood of the Fir. m, m. Medullary ray. f, f, f, f. Large cells formed in the spring. h, h. Small cells formed in late summer and autumn. The cells from f to w constitute one ring of growth, while the large cells above w are the beginning of a succeeding year's growth.—(*After Vines.*)

plastic materials available throughout the season have not been shown to be efficient causes.

In roots the elements of the xylem have, as a rule, larger cavities, and the demarkation of rings of annual growth is not so apparent.

In many woody plants changes in the color and general character of the inner and older xylem portions arise through the filling of the cell-cavities, and, finally, the infiltration of the walls with coloring substances,

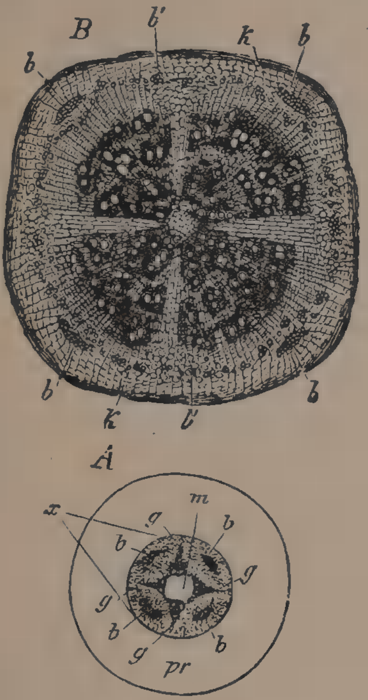

FIG. 351.—Cross-section of Young Root of *Phaseolus multiflorus*. *A*. *pr*. Cortex. *m*. Pith. *x*. Stele. *g*, *g*, *g*, *g*. Primary xylem bundle. *b*, *b*, *b*, *b*. Primary phloëm bundle; in this instance the cambium zone, although not shown in the figure, has the same location as shown in figure 347. *B*. Cross-section through an older root of the same plant. *b′*, *b′*. Secondary bast. *k*, *k*. Periderm. The remaining letters refer to the same tissues as the corresponding letters of figure *A*. By comparing *A* and *B* it will be seen that the cambium has added only medullary rays in front of the primary xylem, but a secondary xylem in front of the primary phloëm.—(*After Vines.*)

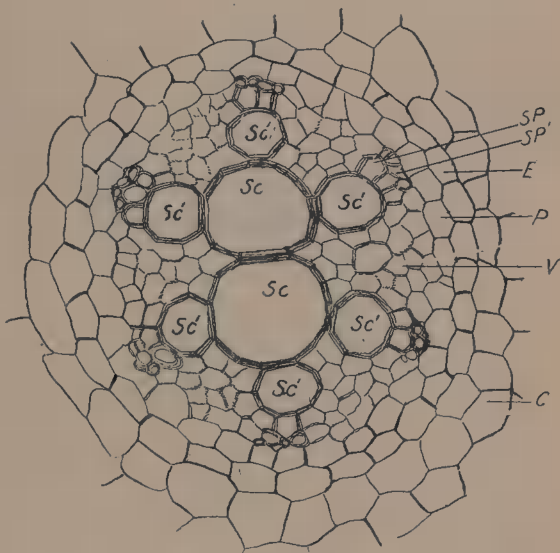

FIG. 352.—Portion of Cross-section through Root of *Allium cepa*. *C*. Cortex. *E*. Endodermis. *P*. Pericycle. *SP*, *SP′*. Spiral tracheal tubes. *Sc*, *Sc*, *Sc′*, *Sc′*, *Sc′*, *Sc′*, *Sc′*, *Sc′*. Reticulately thickened tracheal tubes. *V*. Phloëm portion.—(*After Strasburger.*)

gums, and resins. The tracheal tubes are in this way rendered less passable to water. Thus, the old xylem loses its conductive function, but is made all the more serviceable as a strengthening tissue.

In monocotyledons, even in those which possess a peripheral meristematic zone, no rings of annual growth are formed (Fig. 341).

The roots of dicotyledons and gymnosperms grow in thickness in essentially the same manner as the stems. The variations in minor details

are due to the radial arrangement of the bundles in roots. In roots (Fig. 351) the bundles are formed nearer to the center than in stems. The first-formed elements of both primary xylem and phloëm occur at the periphery of the bundles, and the later elements are formed successively toward the center, so that in some cases, as in the roots of *Allium cepa* (Fig. 352), the xylem elements of the different bundles may meet at the center. In other cases the bundles form a hollow ring, within which thin-walled parenchyma (Fig. 353) or thick-walled sclerenchyma (Fig. 354) occurs.

Just outside the bundles, and separated from them by one or a very

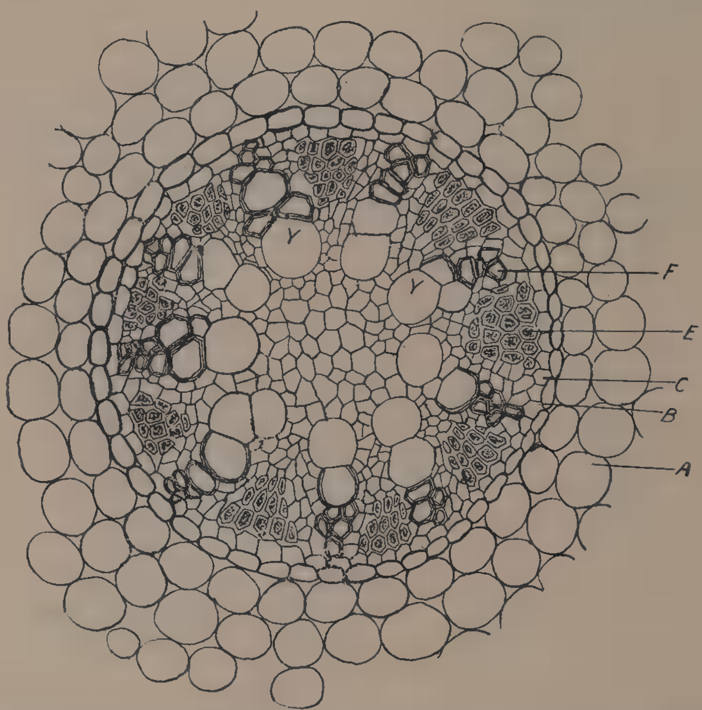

FIG. 353.—Cross-section through a Portion of a Root of *Acorus calamus*. *A*. Cortical parenchyma. *B*. Endodermis. *C*. Pericycle. *E*. Phloëm. *F*. Xylem. At *Y*, *Y*, are large tracheal tubes, which were formed last, the narrow tubes near the periphery of the xylem being formed first. At the center of the root, within the circle of vascular bundles, occur thin-walled parenchymatous pith cells.—(*After Frank*.)

few rows of cells, a protective sheath called the endodermis is formed (Figs. 352, 353, 354). This in cross-section has the form of a ring; it is, however, a cylinder which demarks the bundles from the outlying cortex. The character of the cells of the endodermis varies somewhat in different plants. As a rule, its walls are more or less thickened and suberized. In cross-sections the radial walls have a peculiar shaded appearance, due to radially extended wrinkles in these walls. This occurs, however, only where the radial walls alone are suberized, and is probably due to the fact that suberized walls are less elastic than cellulose walls, and, having once reached a certain expansion due to the turgidity

of the cells, they gather in folds rather than contract when the turgidity is diminished. The thickened and suberized walls of the endodermis may protect the bundles against mechanical injuries. According to Strasburger, the suberized radial walls which are not appreciably thickened may possibly have the mechanical use of holding the cells more firmly together when the endodermis is subjected to strong pressure from within the circle outward, and so, by preserving intact the sheath which shuts out the aërating tissues of the cortex from the bundles, contribute toward

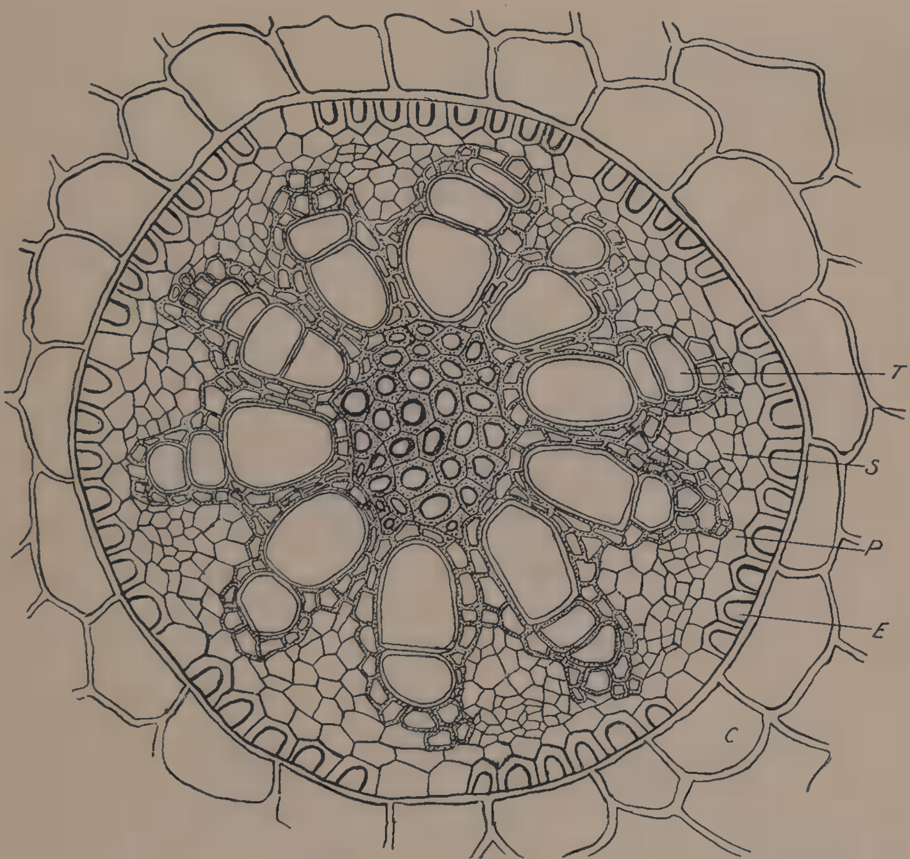

FIG. 354.—Cross-section through a Portion of Root of *Veratrum album*. *C*. Cortical parenchyma. *E*. Endodermis. *P*. Pericycle. *S*. Phloëm. *T*. Xylem. At the center, within the circle of vascular bundles, occur thick-walled sclerenchymatous cells.—(*After Tschirch.*)

the maintenance of the negative pressure in the water-conducting elements—namely, the tracheal tubes and tracheids; the disturbance of this negative pressure would probably prove a hindrance to the rise of the water. When the walls of the endodermis are considerably thickened and suberized, both radially and tangentially, usually one of its cells standing before each of the xylem bundles remains thin-walled and unsuberized (Fig. 354), and so makes possible the transmission of water

from xylem to the cortex. The tissues inclosed by the endodermis constitute the central cylinder or stele (see figures 352 to 354).

The layer of cells immediately within the endodermis is known as the pericambium or pericycle. In older portions of roots the cortex often sloughs away, and then the endodermis or cork produced by division of the cells of the pericycle must serve the purpose of the epidermis or periderm in giving protection against external sources of injury. The formation of lateral roots begins by the division of the cells of the pericycle.

The growth of roots in thickness takes place through the activity of cambium cells, which are produced by the division of the cells of the parenchyma lying immediately within the phloëm and without the xylem respectively. Xylem and phloëm cambium extend laterally until they finally meet and form a complete sinuous ring (Fig. 347, *C* in A). By means of this cambium belt new phloëm is added to the primary phloëm, and new xylem just inside this, so that a collateral bundle is formed. As to the primary xylem, new elements may be added to this and a phloëm part formed outside; but frequently the cambium which stands in front of the primary xylem fails to produce either xylem or phloëm elements, and gives rise to medullary ray cells instead (Fig. 351). In the older parts of roots the sinuosities in the cambium ring become obliterated, and the differences in the structure of stem and root become less marked.

CHAPTER VIII.—THE DISTRIBUTION OF TISSUES IN LEAVES.

The differentiation of leaves as lateral outgrowths of the stem begins in the primordial meristem quite close to the vegetative point (Fig. 321, *L*). The primordial meristem of the leaf-outgrowth soon becomes differentiated into protoderm, procambium, and ground meristem, which become continuous with the corresponding tissues of the stem, excepting that the ground meristem of the pith of the stem is not involved. In the mature leaf, then, the epidermis is continuous with the epidermis of the stem, the vascular bundles with the vascular bundles of the stem, and the ground parenchyma with the ground parenchyma of the cortex of the stem.

The leaf is the member of the plant body which has for its specific

FIG. 355.—Part of Transverse Section of Leaf-blade of *Ruta graveolens*. *cp'*. Epidermis of the upper surface. *cp*. Epidermis of the lower surface. *st*, *st*. Stomata. *pl'*, *pl''*. Palisade cells. *sp'*, *sp''*, *sp'''*. Spongy tissue. *k*. Crystal sac. *vs*, *vs*. Small vascular bundles. *sc*. Lysigenous oil glands, the upper one empty.—(*After Strasburger*.)

function the manufacture of food substances from the water which has come up from the soil, and the carbon dioxide from the atmosphere, utilizing the energy of the sunlight to accomplish this; the structure and arrangement of the tissues of the leaf must therefore be correlated with the several conditions attending this function. Under normal meteorological conditions the greater part of the leaf is composed of chlorophyll-bearing parenchyma; in regions subject to periods of drought, however, the leaves are often much thickened by the multiplication of the parenchyma, much of which toward the interior is destitute of chlorophyll and serves as a water reservoir.

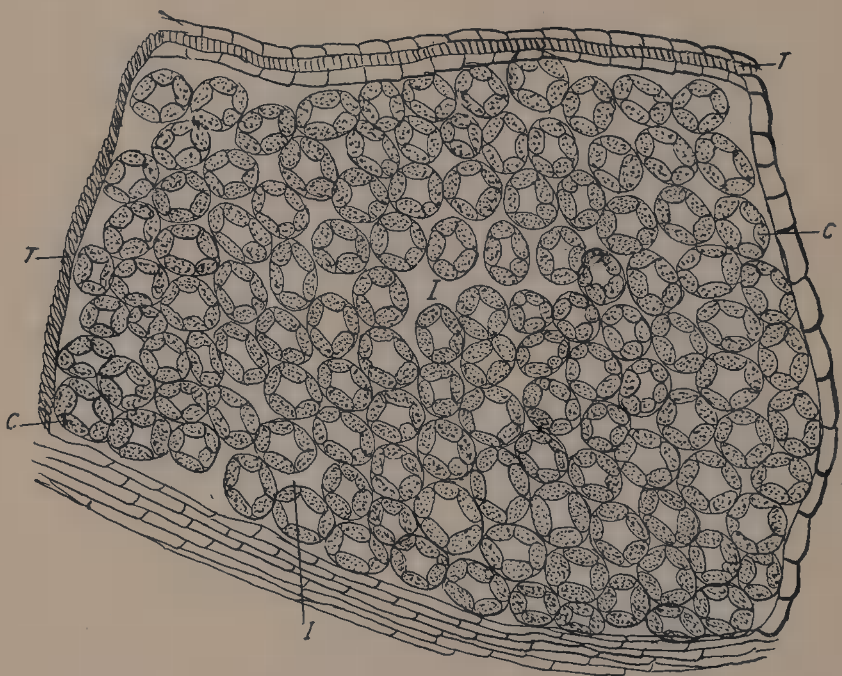

FIG. 356.—Section through Palisade Parenchyma Cells of Leaf of Sunflower, Cut Tangentially to the Surface of the Leaf. *I*, *I*. Intercellular spaces. Palisade cell lined with chloroplasts: *C*, *C*. Chloroplasts. *T*, *T*. Tracheal tube.

A typical leaf is expanded into a thin lamina with its broad surfaces more or less perpendicular to the incident rays of the sun, by which means a large amount of the radiant energy from the sun is intercepted by the leaf. The epidermis is fairly translucent, since its walls are uncolored, and its cells, aside from the protoplasts which line the walls, contain for the most part only water. Just beneath the epidermis, on the upper side, is usually one, but sometimes more than one, row of chlorophyll-bearing parenchyma cells, with their long axes perpendicular to the surface of the leaf and parallel to the incident rays of the sun (Fig. 355). These cells, known as the palisade parenchyma, stand close together, as a rule; but, being

cylindrical in shape, there are fairly large intercellular spaces between them, even when they are in absolute contact for a part of their surface (Fig. 356). Below the palisade cells and extending to the lower epidermis are chlorophyll-bearing parenchyma cells having a very loose arrangement; these are called the spongy parenchyma. About midway between the upper and lower surfaces the vascular bundles traverse the parenchyma tissue, branching repeatedly, the ultimate branches either uniting with each other or ending free among the parenchyma cells (Fig. 357).

About these tissues the epidermis of the upper and lower surface forms a water-proof covering, whose continuity is broken only by the stomata, which in most plants have the power to open and close as the plant has need. The stomata are, as a rule, more numerous on the lower than on the upper side. Just beneath the stomata the parenchyma cells are arranged to form an air-chamber, which communicates on all sides with the intercellular spaces.

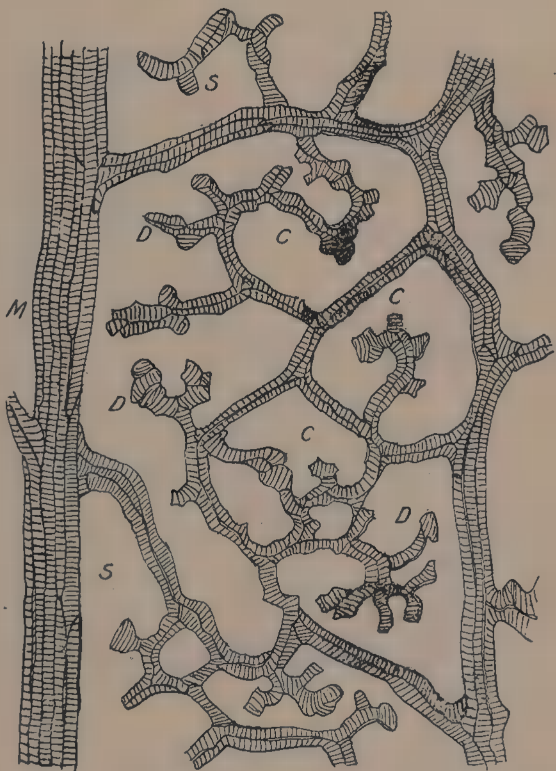

FIG. 357.—Ramifications and Terminations of Vascular Bundles in the Leaf of *Anthyllis vulneraria*. *M*. Main bundle. *S*, *S*. Secondary bundles. *C*, *C*, *C*. Closed meshes. *D*, *D*, *D*. Free termination of bundles in the parenchyma of the leaf.—(*After Sachs.*)

The problems which the structure of the leaf must be adapted to meet are as follows: (1) The water brought up from the soil must be equally distributed to, and absorbed by, the chlorophyll-bearing parenchyma cells; (2) the carbon dioxide from the atmosphere must gain access to the interior of the leaf and become absorbed by the chlorophyll-bearing parenchyma; (3) the water which has been absorbed by the parenchyma cells must be evaporated from them in order that a flow of water may be kept up, bringing with it the necessary salts from the soil; (4) the sunlight must penetrate to the deeper cells of the leaf, in order that its energy may be arrested by the chloroplast of both the palisade and spongy paren-

chyma; (5) finally, the substances which the chloroplasts, by the aid of the sunlight, have constructed from the carbon dioxide and water must be collected and transported from the leaf to those parts of the plant where growth is taking place or where reserve materials are being stored up for use at some future period. The ultimate branches of the vascular bundles, which are so numerous and well distributed that the point of a pin could scarcely be inserted anywhere into the leaf without penetrating one of them, and which are closely applied to the parenchyma cells, solve the first of these problems. The stomata and numerous intercellular spaces meet the second and third, for the vapor of water from the leaf can pass out by the same channels through which the carbon dioxide enters. The fourth problem is provided for by the translucency of the epidermis and by the shape and arrangement of the palisade cells, by the open way of the intercellular spaces of the palisade parenchyma, and by the position of the chloroplasts against the walls which are parallel to the sun's rays. It will be seen that all of these circumstances combine to permit the penetration of the sunlight to a considerable depth. The fifth problem is met by the position of the vascular bundles midway between the upper and lower surfaces—a position which enables the bundles to gather materials from the parenchyma cells of both sides; by the direction of the longitudinal axis of the palisade cells toward the center of the leaf—namely, toward the bundles which are to carry away the products of these cells; by the general trend of the spongy parenchyma cells in the same direction; and by the intercellular spaces which prevent an interchange of materials laterally between the parenchyma cells, and so compel the outward currents to pass from cell to cell in the direction of the bundles.

In many plants certain of the parenchyma cells radiate outward from the bundles, and so transmit materials to the latter by the shortest possible route (Fig. 358).

The chloroplasts (Fig. 356, *C*) are the organs of the spongy and palisade parenchyma cells which have the specific function of appropriating the carbon dioxide and water and radiant energy of the sun, and of producing the carbohydrate food substances of the plant; the chloroplasts should therefore receive special consideration here.

According to Arthur Meyer, a chloroplast consists of a protoplasmic stroma which is colorless or pale yellow, in which are imbedded viscous droplets termed grana, which are colored dark green by the chlorophyll.

The form of the chloroplasts is variable. Among the Algæ they may be in the form of a band, disk, plate, or trough, and these forms may be modified by convolutions, serrations, etc. In the higher plants, however, the chloroplasts are almost invariably in the form of elliptical or rounded grains, and are therefore frequently spoken of as chlorophyll

grains or granules. In cells which are specially devoted to assimilation the chloroplasts in the higher plants, and frequently in the lower forms, occur in large numbers imbedded in the protoplast, which, in mature cells, has become a thin membrane lining the cell-wall. The chloroplasts accordingly have a parietal position, as a rule. It is evident that the small size of the chloroplasts is conducive to the rapid absorption of raw materials and elimination of plastic materials which have been formed in them, and results in the exposure of relatively more surface to the absorption of radiant energy. The parietal position of the chloroplasts,

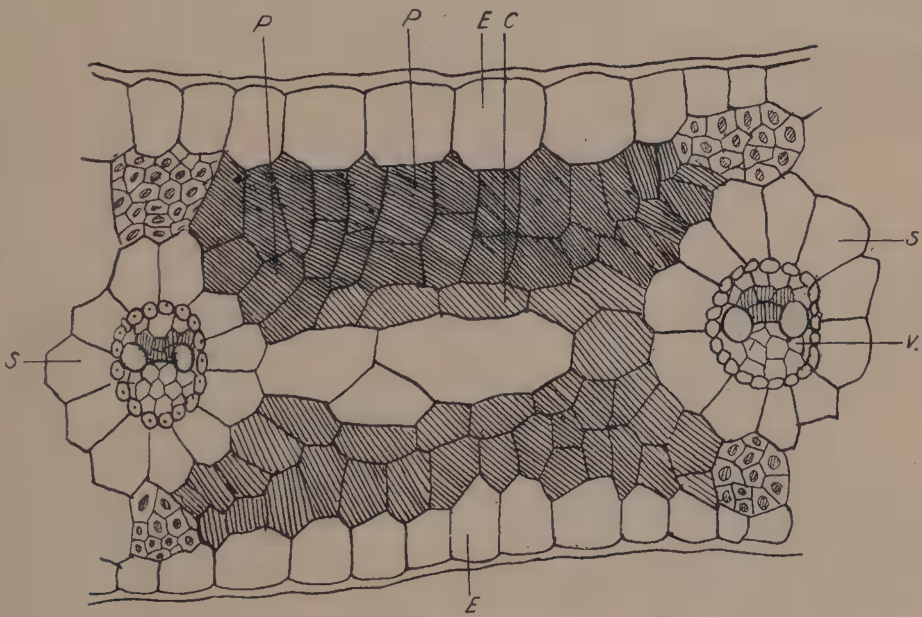

FIG. 358.—Cross-section through a Leaf of *Cyperus alternifolius*. *E*, *E*. Upper and lower epidermis. *V*. Vascular bundle. *S*, *S*. Parenchyma sheath of vascular bundle. *P*. Chlorophyll-bearing palisade parenchyma. *C*. Parenchyma cells not so rich in chlorophyll as the foregoing, which serve the purpose of collecting the products of assimilation and transporting them laterally to the parenchyma sheath of the bundles.—(*After Haberlandt.*)

and particularly where these are in proximity to the intercellular spaces, facilitates the absorption of carbon dioxide.

The chlorophyll has the function of arresting the vibrations of the sunlight of certain wave-lengths, and converting them within the chloroplast into chemical energy, which is then employed by the chloroplast in the dissociation of the elements of the carbon dioxide and water absorbed by the chloroplast, and the formation of starch or a soluble carbohydrate by the synthesis of the dissociated elements.

That the chlorophyll has the power of arresting vibrations of a certain wave-length more than others is shown by the spectrum of chlorophyll, where absorption bands appear in the red and across the violet end.

It is, perhaps, impossible to give an exact chemical expression of the

processes which take place within the chloroplast during the formation of carbohydrate from carbon dioxide and water. There are certain well-established facts, however, which afford a basis for conjecture. Starch is the first visible product of the activities of the chloroplast, and is always formed within the chloroplast, and, hence, always by the chloroplast. The starch in the chloroplasts is not formed in the absence of carbon dioxide; it is not formed in the absence of chlorophyll; it is not formed in the dark—that is, unless the chloroplasts are supplied with energy from the sun or some artificial source. During the process of starch formation as many molecules of oxygen are evolved as of carbon dioxide absorbed. The last fact might be accounted for by the simple equation: $6CO + 5H_2O = C_6H_{10}O_5 + 6O_2$—that is, one molecule of starch and six molecules of oxygen result from the readjustment of the elements of six molecules of carbon dioxide and five molecules of water. Sometimes, how-

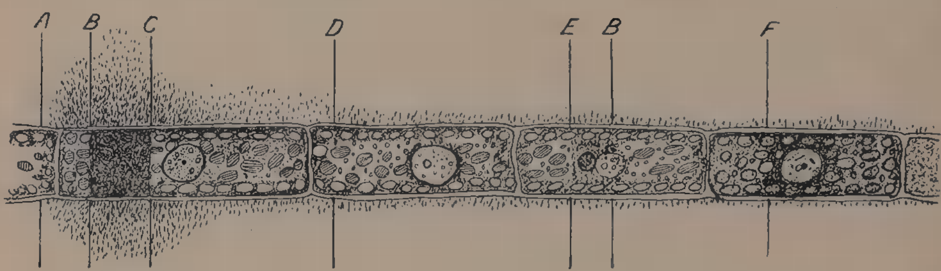

FIG. 359.—A Filament of Œdogonium, as Seen when Mounted in a Drop of Water Containing Oxygen-loving Bacteria and Illuminated by Means of Light which has Passed through a Spectroscope Placed Beneath the Stage of the Microscope. The bacteria collect along the filament in greatest numbers between the lines *B* and *C*, which corresponds to the region of greatest absorption by the chlorophyll of the filament. Engelmann saw an accumulation of bacteria about the second region of absorption beyond *F*, but Pfeffer could not confirm this.—(*After Pfeffer.*)

ever, and notably in the monocotyledons, some other carbohydrate than starch is formed. The fact that as many molecules of oxygen are evolved as of carbon dioxide taken on, might be accounted for by another equation; thus, $CO_2 + H_2O = CH_2O + O_2$. The CH_2O (formic aldehyde) might then be polymerized to form grape-sugar, $6CH_2O = C_6H_{12}O_6$. It may be, however, that the process is not so simple and direct as here represented; indeed, there are observations which indicate that formic aldehyde, or a nearly allied compound, is first formed, and that this unites with the nitrogen and sulphur, which have been brought up by the water from the soil, to form proteid, and that the carbohydrates are finally derived from this.

The formation of carbohydrates from carbon dioxide and water under the influence of the sunlight has been called carbon assimilation and, more recently, photosynthesis.

The fact that oxygen is evolved during the process of carbon assimila-

tion, has been used by Engelmann to show the relation of the vibrations arrested by the chlorophyll to the assimilation process. He placed a filamentous alga in a drop of water and adjusted it for observation with a microscope; to the drop of water he added certain bacteria which show active movements only in the presence of oxygen; he then illuminated the alga from beneath with light which had passed through a microspectroscope, and observed that the bacteria collected in greater numbers along the alga at those portions of the spectrum which are shown to be absorbed by chlorophyll. Accordingly, the alga must have been assimilating carbon and evolving oxygen at those places rather than where it was illuminated by other portions of the spectrum (Fig. 359).

The various structures, forms, sizes, and positions which the foliage leaves of plants assume are, in the main, an expression of an attempt to carry on the function of carbon assimilation to the best advantage under the specific environment.

CHAPTER IX.—REAGENTS AND PROCESSES.

The different kinds of cell-walls and cell-contents may be demonstrated by the use of reagents which, in some cases, impart characteristic colors to walls and contents; in other cases act as selective solvents, dissolving some of the walls and contents, leaving others undissolved; or the reagents may produce precipitates the nature of which furnishes good evidence regarding the character of the substance which has united with the reagent to produce the precipitate.

These reagents, together with their uses, will now be given in alphabetical order.

Acetic acid dissolves most ethereal oils, while most fatty oils are insoluble in it; dissolves calcium carbonate with evolution of CO_2, while calcium oxalate is unaffected by it, and it therefore serves to distinguish between these two salts of calcium; solvent of crystals of hesperidin which have been deposited from the cell-sap of oranges, etc., when these have lain for some time in alcohol; when various lichens are treated with it, crystals of calycin in acicular form are deposited after the lichens thus treated have been powdered and dried; one per cent. solution dissolves globoids in aleurone grains, while any crystals of calcium oxalate present are unaffected by it; when pieces of potatoes, carrots, etc., are macerated in it, the separate cells become isolated. Used in the preparation of various fixatives.

Albumen.—The white of egg is used with an equal amount of glycerine and a trace of salicylate of soda for fixing microtome sections to the glass slide, the sodium salicylate acting partly as an antiseptic.

Alcannin.—This is a coloring matter, obtained from the roots of *Alcanna tinctoria*. A tincture of alcannin to be used as a reagent is prepared by Guignard as

follows: 10 Gm. of alcannin are pulverized and added to 30 Cc. of absolute alcohol; the solution is filtered and allowed to evaporate in a drying oven; the residue is then dissolved in 5 Cc. of glacial acetic acid, and this solution is mixed with 50 Cc. of 50 per cent. alcohol. After twenty-four hours the solution is filtered and is ready for use. The solution prepared in this way is said not to be subject to precipitation on long standing. When sections are being treated with this reagent under a cover-glass, evaporation should be guarded against by the addition of drops of 50 per cent. alcohol as needed. A quicker way of preparing an alcannin solution is to extract the coloring matter from roots of Alcanna in absolute alcohol, and then to add an equal bulk of distilled water and filter the solution.

(1) Suberized and cutinized walls, when treated with a solution of alcannin for some hours, take on the color of the alcannin. (2) Alcanna tincture mixed with 1 per cent. glacial acetic or formic acid is used to fix and stain sections of elaioplasts from fresh material. (3) Where sections containing fatty oils are treated with tincture of alcannin, the oil is colored red. Sections containing ethereal oils and resins behave in the same manner, in that the ethereal oils and resins are stained red.

Alcohol.—The commercial alcohol obtained in this country is about 95 per cent. alcohol. In making alcohols from this of different strengths it answers all practical purposes to proceed as if the commercial 95 per cent. alcohol were absolute—that is, very nearly 100 per cent. Thus, if 50 per cent. alcohol is desired, 50 Cc. commercial alcohol and 50 Cc. distilled water will give sufficiently accurate results for all histological work. If absolute alcohol is desired, it may be prepared by pouring the commercial alcohol over unslaked lime, and then distilling from this over a water-bath. Or copper sulphate may be burned until all the water of crystallization is driven off and a white powder results; then the commercial alcohol may be poured over this, and the white powder will become blue again from the water absorbed from the alcohol. The alcohol should then be filtered off and kept tightly corked from the air.

(1) Used in a series of different strengths (from lower to higher) for hardening plant tissues. (2) When sections of plant tissues containing potassium nitrate, dulcite, asparagin, or piperine are treated under the cover-glass with strong alcohol, which is then allowed to evaporate, the substances enumerated will crystallize out in their characteristic forms. (3) When pieces of plants containing inulin have lain for some time in 50 or 70 per cent. alcohol, the inulin is precipitated in the form of sphærocrystals. (4) Seventy per cent. alcohol is used for preserving plant tissues indefinitely, but to avoid shrinkage and disintegration of the protoplasts in the case of very delicate or meristematic tissues the material should first have been fixed and brought, by slow degrees, to the 70 per cent. alcohol, as elsewhere described. Material which has been preserved for a long time in 70 per cent. or stronger alcohol is apt to be quite brittle; when desired, the brittleness may be removed by placing the material for an hour or so in water and then back into the grade of alcohol from which it was taken. Alcohol is used in the preparation of various stains and reagents. The details of its use will be given under the various formulæ where it occurs.

Ammonium Carbonate.—Albumen tannate in solution in the cell-sap of many plants may be precipitated out by the addition of ammonium carbonate. If species of Spirogyra are treated with a 0.1 per cent. solution of ammonium carbonate, a fine-grained precipitate of albumen tannate is apt to occur within the cells. On treating again with water, so that the reagent is washed out, the precipitate is dissolved. This reaction may be carried out without causing the death of the cells.

Ammonium Molybdate.—A concentrated solution of ammonium molybdate is

made in a saturated solution of ammonium chloride. When sections containing tannins are treated with this, a yellow precipitate is usually produced.

Ammonium Vanadate.—This is used as a test for solanin. The sections are treated with a solution prepared by dissolving 1 part of ammonium vanadate in 1000 parts of a mixture of 98 parts of concentrated sulphuric acid and 36 parts of water. If solanin is present, a yellow color appears, which merges into orange, then different shades of red, and finally into violet, and then all color disappears.

Balsam.—Canada balsam dissolved in xylol is, on the whole, the best medium for making permanent mounts of sections under a cover-glass. For the method of doing this see page 535. Balsam in xylol can be obtained ready prepared of the dealers.

Barium Chloride.—This is sometimes used to distinguish calcium oxalate from calcium sulphate. When barium chloride is run under the cover-glass, calcium oxalate, if present, is left unchanged, while a fine granular layer of barium sulphate comes to incrust any crystals of calcium sulphate. (2) To determine the presence of tartaric acid, barium chloride and antimonic oxide in hydrochloric acid are run under the cover-glass, producing, with tartaric acid, rhombic crystals of antimonium-barium tartrate, whose obtuse angles measure 128°.

Benzoazurin.—This is used to differentiate the mycelium of a fungus from the tissues of the host upon which it is parasitizing. The sections are placed in an aqueous solution of benzoazurin and rosazurin, to which is added a 20 per cent. solution of sodium carbonate. The sections lie in this solution for two or three hours. They are then rinsed in water and examined in dilute glycerine containing 2 per cent. of copper sulphate, which tends to fix the stain more permanently in the tissues. By this means the cellulose membranes of the host are stained blue and the mycelium of the parasite a rose-red.

Benzol.—Used in detecting caffeine, thus: Sections are heated on the slide in a drop of distilled water until bubbles arise, then the water is allowed to evaporate, and the residue is dissolved with a drop of benzol. The benzol is then allowed to evaporate and the caffeine is deposited on the edge of the drop in the form of colorless needle-crystals.

Berlin Blue.—Useful in the study of the growth in thickness of the cell-membranes. In the study of marine algæ—notably, *Caulerpa prolifera*—it is used in the following manner: A vigorous alga is submerged for a few seconds in a mixture of 1 part of sea-water with 2 parts of fresh water in which has been dissolved sufficient ferrocyanide of potassium to give it the specific gravity of sea-water. The alga is then rapidly rinsed in sea-water and placed for about two seconds in a mixture of 2 parts of sea-water and 1 part of fresh water, to which has been added a few drops of freshly prepared ferric chloride. This produces in the membranes of the alga a precipitate of Berlin blue. The alga is then transferred to sea-water for further growth. In case new lamellæ are added to the membranes, the new portions will appear colorless, while the older portions will appear blue because of the Berlin blue which was precipitated in them.

Bismarck Brown.—This is preeminently a nuclear stain. The powder is soluble with difficulty in water. It is a good plan to treat with boiling water and after a day or two to filter. Or a saturated solution may be made in 70 per cent. alcohol. Although Bismarck brown stains rapidly, it does not overstain. It may be used for staining *in toto* or for staining sections on the slide.

Blue, Turnbull's.—Produced by combining ferrocyanide of iron with ferrous

lactate. Used in the same manner as Berlin blue, but is considered, on the whole inferior to the latter.

Boric Acid.—Used as a mounting medium for sections containing mucilaginous membranes. The sections are cut from dry material and placed in a 10 per cent. solution of neutral lead acetate to harden the mucilaginous layers. Then the sections are stained in a solution of methyl blue, washed in water, and mounted under a cover-glass in a 2 per cent. solution of boracic acid. The cover-glass should be sealed down with a mixture of paraffin and vaseline, which is applied with a brush while melted.

Borax-carmine.—A 4 per cent. solution of borax is made and to it is added 3 per cent. of carmine; an equal bulk of 70 per cent. alcohol is then added to this. The mixture is left standing for a day or so and then filtered. Sections should lie in the stain for about twenty-four hours, and should then be transferred without previous washing to acidulated alcohol, made by adding 4 drops of hydrochloric acid to 100 Cc. of alcohol. Here they should remain until they become bright and transparent. This is a useful stain for aleurone grains, for differentiating cell-contents from cell-walls when the sections are subsequently stained with methyl green, and much used also in the differentiation of the cell-contents of filamentous algæ.

Bordeaux Red.—Used in conjunction with hæmatoxylin in staining nuclear figures, particularly where Heidenhain's platinic chloride fixative has been used. The sections are placed in a weak aqueous solution of the Bordeaux until they are intensely stained; they are then rinsed and placed in a 2 to 5 per cent. solution of iron oxide-ammonium sulphate for three hours. If the sections are mounted on a slide, they should be placed upright in this solution, so that any precipitate may not gather on the slide. Then the sections are carefully washed in an abundance of water, and placed for twenty-four hours in a solution of hæmatoxylin prepared as follows: 1 Gm. of hæmatoxylin is dissolved in 10 Gm. of alcohol and 90 Gm. of water. This is allowed to stand for about four weeks, and then an equal bulk of distilled water is added. The stain is then ready for use. When the sections are taken from the hæmatoxylin, they will be found overstained; they are, therefore, rinsed and placed in a 2.5 per cent. solution of ferric-ammonium sulphate, where they remain until examination of the sections under the microscope shows them to have the proper intensity of stain. The sections are then thoroughly rinsed in water and passed through alcohol and xylol before mounting in balsam.

Borodin's Method.—To determine the nature of a precipitate Borodin treats it with a saturated solution of the same substance as the precipitate is supposed to be. Thus, if the precipitate is supposed to be asparagin, it is treated with a saturated solution of asparagin. If the precipitate dissolves by this treatment, it is then some other substance than asparagin. This method is not very reliable for substances which are very readily soluble, such as potassium nitrate. Care must be taken that the solution used for the test is entirely saturated.

Brown Discoloration of Material in Alcohol.—Some plants, such as Monotropa, are apt to become quite brown in alcohol. This can be prevented by placing the fresh material in alcohol which is acidulated by vapor of sulphuric acid in the following manner: For each 100 Cc. of alcohol several cubic centimeters of 80 per cent. sulphuric acid are poured over ½ of a Gm. of sodium sulphite, and the vapors arising are conducted into the alcohol. This operation need require hardly more than a minute. After twenty-four hours the material should be transferred from the acid alcohol to neutral alcohol. Thereafter the material will not discolor, and will take stains very well when used for histological purposes.

Calcium Nitrate.—(1) Used to differentiate more clearly the lamellæ of starch-grains. Potato starch, for instance, is placed in a rather strong aqueous solution of methyl violet. After the grains have become deeply colored, they are treated with a weak solution of calcium nitrate, when the methyl violet becomes precipitated, particularly in the less dense lamellæ of the starch-grains. (2) Calcium oxalate is precipitated in the form of crystals when sections containing oxalic acid are treated with a solution of calcium nitrate. The calcium nitrate is thus a test for the presence of oxalic acid.

Canarin.—This is often used as a stain for tissues which have been cleared in caustic potash. Canarin is not affected by this reagent.

Carbolic Acid (Phenol).—Used as a clearing agent. If leaves which have been hardened and bleached in alcohol are placed in 3 parts of turpentine and 1 part of carbolic acid, or in pure carbolic acid, the leaves will become so transparent that their cellular structure may be made out from one surface to the other. Pollen-grains may be made transparent in the same manner.

Carmalum, Mayer's.—Carminic acid 1 Gm., alum 10 Gm.; dissolve in 200 Cc. of hot distilled water; filter and add a few crystals of thymol, or 0.1 per cent. of salicylic acid, or 0.5 per cent. of sodium salicylate. This stains material well in bulk, with little danger of overstaining. If this happens, it may be corrected by washing with a 0.1 per cent. solution of hydrochloric acid. Material which has been stained in bulk with carmalum may be sectioned, and the sections may then be double-stained with some aniline stain, such as blue de Lyon. See borax-carmine for another carmine stain. Very fine double staining may be achieved by placing sections first in an aqueous solution of iodine green and then for a somewhat longer time in carmalum. By this treatment lignified membranes are stained by the iodine green, while the unlignified membranes are stained by the carmalum.

Cedar Oil.—Sections which are to be mounted in balsam may first be examined in cedar oil to determine their fitness for permanent mounts; if they are satisfactory, the cedar oil may be drained off and the balsam immediately added to the slide. Cedar oil has a clearing effect on sections which are treated with it.

Thicker cedar oil with a refractive index of about 1.515 is used as an immersion fluid for homogeneous immersion lenses.

Cedar oil is often used as an intermediary between alcohol and paraffin in paraffin-imbedding, but for plant tissues chloroform is rather to be recommended.

Chloral Carmine.—This is useful in clearing pollen-grains and staining their nuclei at the same time. It is prepared as follows: Carmine 0.5 Gm. and 30 drops of officinal hydrochloric acid (specific gravity, 1.13 or 17° B.) are added to 30 Cc. of alcohol, and this is heated for about thirty minutes on the water-bath; then, after cooling, 25 Gm. of chloral hydrate are added, and the solution is filtered until clear.

Chloral Hydrate.—Dissolve 8 parts of chloral hydrate in 5 parts of water. The chloral hydrate may be taken in grams and the water in cubic centimeters. This is one of the best clearing agents. Whole leaves, when boiled in this solution, clear quickly to such an extent that they may be studied by transmitted light throughout all of the cell-layers. Crystals in leaves may be plainly demonstrated in this way. This reagent is also very useful in clearing pollen-grains and embryos within the ovules.

Chloral Hydrate-iodine.—Dissolve 5 parts of chloral hydrate in 2 parts of water and add a small amount of potassium iodide-iodine. This is the best reagent for demonstrating the presence of starch in chlorophyll corpuscles and in pyrenoids, or in any situation where the starch is surrounded and obscured by other substances.

Chloroform.—Used as a solvent for paraffin in the process of imbedding in paraffin. See page 529. One of the best solvents of fatty oils and of carotin. Solvent of most of the constituents of suberin.

Chloroiodide of Calcium.—Useful in the determination of cellulose, which it colors violet. Prepared by dissolving 0.5 Gm. potassium iodide and 0.1 Gm. iodine to 10 Cc. of a concentrated solution of calcium chloride. A slightly elevated temperature should be employed in the solution. The solution may be cleared by decanting carefully or filtering through glass-wool.

Chloroiodide of Zinc.—Prepared by dissolving zinc in concentrated hydrochloric acid to saturation and then evaporating to the consistency of concentrated sulphuric acid, adding as much potassium iodide as can be taken up, and then crystals of iodine until no more is dissolved. Another method is to dissolve 20 parts of chloride of zinc, 6.5 parts of potassium iodide, and 1.3 parts of iodine in 10.5 parts of distilled water. Chloroiodide of zinc solutions should be kept in the dark. This reagent is one of the most generally useful in determining the character of plant membranes. By it cellulose walls are colored violet, lignified membranes a yellowish-brown, cutinized and suberized membranes from yellow to yellowish-brown. When sections containing sieve tubes are treated with chloroiodide of zinc and a rather weak solution of potassium iodide-iodine, the walls of the sieve tubes appear violet, while the pits in the sieve plates are a reddish-brown, due to the strands of protoplasm which penetrate them; the callose plates are stained a reddish-brown. Mucilaginous walls are colored violet by this reagent. Chloroiodide of zinc stains protoplasmic cell-contents from yellow to brown, and starch from purple to almost black.

Chlorophyll Solution.—A freshly-prepared strong solution of chlorophyll in alcohol is used to demonstrate suberized and cutinized membranes. When sections are kept in the chlorophyll solution for an hour or so in the dark, cutinized and suberized membranes are stained green, while lignified and cellulose membranes remain unstained. The chlorophyll solution will not keep, and should be freshly prepared whenever needed.

Chrom-acetic Acid.—Prepared by mixing 70 Cc. of 1 per cent. chromic acid with 5 Cc. of glacial acetic acid and 90 Cc. of water. Particularly good for fixing algæ. The algæ should remain in the fixative for twelve hours, then they should be thoroughly washed out in running water or in water which is frequently changed, and thereafter they may be preserved indefinitely in 10 per cent. glycerine, to which a bit of camphor has been added. If it is at any time desired to stain and imbed the algæ which have been fixed and preserved as above, the 10 per cent. glycerine in which the algæ are preserved may be evaporated in the drying oven until quite concentrated, and the algæ may be washed out in strong alcohol; they may then be double-stained in the following manner: To the strong alcohol (95 per cent.) in which the algæ are lying are added a few drops of a concentrated solution of magdala red in 95 per cent. alcohol; the algæ are quickly rinsed in alcohol and transferred to a rather dilute solution of aniline blue in 80 per cent. alcohol, where they remain for a few minutes, and are immersed for a few seconds only in a 25 per cent. hydrochloric acid-alcohol solution. The algæ are next rinsed in pure alcohol, and transferred to a 10 per cent. solution of Venetian turpentine. The turpentine is concentrated by the evaporation of the alcohol which was used as the solvent (see Turpentine) in the drying oven. Permanent mounts should be made in the concentrated turpentine.

Chromic Acid.—Solutions of 1 per cent. and 0.5 per cent. have been much used

for fixing plant tissues. The material to be fixed should lie in the chromic acid for a day or more, according to the size of the pieces of material to be fixed. The material should then be thoroughly washed out in water and dehydrated by slow degrees in ascending grades of alcohol (see p. 535). A concentrated aqueous solution of chromic acid may be used as a macerating fluid to cause the separation of tissues into their separate cells. To this end rather thin bits of the tissue to be macerated should be placed in the chromic acid for about half a minute, and then carefully washed in water. This operation may be carried on with sections under the cover-glass. Silicious skeletons of diatoms, incrustations on the epidermis of equisetum, etc., may be prepared by allowing the material to lie in concentrated sulphuric acid until it becomes black, and then, after transferring to a 20 per cent. solution of chromic acid for some minutes, washing thoroughly in water. In the case of equisetum and the like the tissues should be scraped away from the inside down to the epidermis before treatment with the acids. Chromic acid is useful in the recognition of tannins, since sections containing tannins, when treated with a 1 per cent. solution of chromic acid, yield a brownish precipitate.

Clearing Media.—See Carbolic Acid, Cedar Oil, Chloral Hydrate, Canada Balsam, Clove Oil, Glycerine, Javelle Water (or Eau de Javelle), Origanum Oil, Turpentine, Xylol.

Clove Oil.—This is an excellent clearing medium, but it has the power of extracting certain stains, and so can not be used in all cases; it is, however, for this very reason of great advantage in the safranin-gentian violet-orange method of staining. See under this head.

Collodion.—Used as an imbedding medium (see page 534).

Congo-red.—This stain is particularly useful in studying the growth of membranes. Old membranes are, as a rule, left unstained by it, while the newly formed membranes are colored red. In a 0.01 per cent. solution—that is, 1 part of the stain to 10,000 of water—algæ may continue to live and grow, and they are, therefore, well adapted to the study of the growth of membranes with the employment of this stain.

Copper Acetate.—Used in the determination of tannins. Small bits of the plant to be tested are placed in a saturated solution of copper acetate, where they remain for 8 or 10 days; the sections are then placed on a slide in a drop of a 0.5 per cent. solution of ferrous sulphate; after a few minutes the sections are washed in water, then in alcohol, and are finally treated with a drop of glycerine and examined under a cover-glass.

An alcoholic solution of copper acetate, to which has been added a small amount of acetic acid and glycerine, is used to demonstrate glucose in position within the cells where it occurs. The sections are laid in a mixture of the above solution, and an equal volume of sodium hydrate in alcohol, which is brought to boiling on the water-bath. Since glucose is insoluble in alcohol, the cuprous oxide which indicates the presence of glucose in this reaction is found to be deposited within the cells which contain the sugar. For other tests for sugar with a salt of copper see Fehling's Solution. See under Resin in next chapter.

Corallin.—This stain is to be dissolved in a 30 per cent. or a saturated solution of sodium carbonate. It is particularly useful in staining the callose of sieve tubes. It is best to overstain the sections and then to reduce the intensity of the color by immersing the sections in a 4 per cent. solution of sodium carbonate.

Corrosive Sublimate.—See Fixatives.

Cuprammonia.—This should be freshly prepared as needed in the following

manner: Put copper filings into a bottle or flask, which is provided with a ground-glass stopper. Pour concentrated ammonia upon the filings and rock back and forth. Only sufficient ammonia should be used to cover the filings. When the solution will dissolve cotton, it is ready for use. This reagent is a solvent of cellulose. When sections are placed in it for some time and are then rinsed with ammonia and finally with distilled water, crystals of cellulose are precipitated within the cells which are stained blue with chloriodide of zinc, and red with Congo-red. The crystals are again dissolved on the addition of cuprammonia.

Cyanin.—This stain is almost insoluble in water, and should be dissolved in 50 per cent. alcohol. This is a useful stain for fats and all ethereal oils. Sections of fresh material, or material fixed in an aqueous fixative, such as an aqueous solution of corrosive sublimate or picric acid, will be sufficiently stained when left in the cyanin solution for about half an hour. Overstaining may be reduced with glycerine. The alcoholic solution of cyanin, to which has been added an equal bulk of glycerine, is a good stain for suberized membranes, particularly after the sections have been treated with eau de Javelle, which destroys the tannins and prevents the lignified membranes from taking the stain. When sections are placed in a dilute solution of cyanin,—say 20 drops of a concentrated alcoholic solution of cyanin in 100 Cc. of water,—and are then washed in alcohol and placed in oil of cloves containing eosin, the lignified and suberized walls will be stained blue, while cellulose walls will be red. The sections may then be mounted in Canada balsam. When sections are placed for a quarter of an hour in a concentrated alcoholic solution of cyanin, and are then washed in alcohol and transferred for a quarter of an hour to a 5 per cent. ammoniacal solution of Congo-red, the lignified membranes will appear blue, while the unlignified membranes will appear red. After washing in alcohol, such sections may be mounted in Canada balsam.

Dahlia.—An aqueous solution of from 0.001 per cent. to 0.002 per cent. is used for staining live nuclei. The dividing nuclei of *Tradescantia virginica*, for instance, when kept in this stain for a few hours, become weakly stained. The structure of pyrenoids is well demonstrated by fixing them in equal parts of a 10 per cent. solution of potassium ferricyanide and a 55 per cent. solution of glacial acetic acid and then staining with dahlia, and finally swelling the pyrenoids somewhat in a weak solution of potassium hydrate.

Dammar Lac.—Dammar lac is dissolved in equal parts of benzol or xylol and turpentine; the solution is filtered and evaporated to the desired consistency. This is used as a mounting medium the same as Canada balsam; it has a lower refractive index than Canada balsam, and unstained tissues come out more sharply in it than in the Canada balsam.

Decalcification.—Three per cent. of nitric acid in 70 per cent. alcohol is a good decalcifying agent. The material should be left in the solution for several days. Chromic acid has a decalcifying action; a 1 per cent. to 2 per cent. solution should be used, and the material should be left in this until decalcification is found to be complete.

Decolorizing.—Material which has become brown in alcohol may be decolorized in the following solution: To each 100 Cc. of alcohol is added from 0.2 to 0.5 Cc. of concentrated sulphuric acid and as much potassium chlorate as can be transferred on the point of a knife. The material is to lie in this solution for eight or ten days, and is then to be washed a few times in pure alcohol, the material standing for some time in each change of alcohol.

Dehydration.—This is best accomplished by cutting the material into as small pieces as possible, and then placing it in 20 per cent. alcohol, and then into ascending grades of alcohol of 10 per cent. increase at intervals of about two hours. Microtome sections mounted on the slide may be transferred to strong alcohol without injury. In passing from water or aqueous stains to Canada balsam, the material should first come into strong alcohol, and then into xylol to insure complete dehydration, and to infiltrate the material with a solvent of balsam—namely, xylol. Aniline is also a good dehydrating agent. The preparations may pass directly from water into the aniline and from the aniline into the balsam. A stick of potassium hydrate placed in the aniline will keep the latter dehydrated. Potassium hydrate is not soluble in aniline. Very thin microtome sections which are found not to be injured by drying may be allowed to dry, and then may be placed in xylol and thereafter transferred to balsam. See p. 511 for further description of the process of dehydrating.

Desilicification.—This is accomplished by hydrofluoric acid. A glass vessel is coated on the inside with melted paraffin to prevent the action of the acid on the glass. Alcohol is then poured into the vessel and the material is immersed in the alcohol; then the hydrofluoric acid is added, drop by drop. The process should be completed in a few minutes. Care must be taken not to breathe the fumes of the acid, since they attack the mucous membranes.

Diastase.—This may be prepared as follows: Germinate barley in the incubator between pieces of blotting-paper until the plumule has reached a length of about 2 mm.; then dry the barley on the water-bath and grind to a fine powder. When a diastatic solution is desired, pour over 10 Gm. of the powdered barley 1 liter of water containing 2 Cc. of chloroform; let stand for ten hours at about 15° C. and filter. The water filtered off will contain the diastase in solution. Add a little chloroform and preserve in a dark place. Starch-grains may be mounted in this solution under a cover-glass and kept from drying in a moist incubator, and the effect of the diastase on the starch may be studied from time to time under the microscope; or a 1 per cent. starch-paste may be made to which about an equal amount of the diastatic solution may be added, and then at intervals samples from the mixture of starch and diastase may be tested with a solution of iodine. The starch will, after a time, be changed into dextrines and grape-sugar, and will no longer give a blue color when tested with a solution of iodine.

Digestive Fluids.—To remove from sections aleurone grains which are so numerous as to obscure the nucleus, the sections should be treated for twenty-four hours with a digestive fluid prepared by mixing 1 part of pepsin-glycerine with 1 part of pancreatin-glycerine, and 20 parts of a 0.3 per cent. solution of hydrochloric acid. Differences in the character of the protoplasmic cell-contents, and particularly in the dividing nucleus, may be demonstrated by treating sections of fixed material with a digestive fluid made by mixing 1 part of pepsin-glycerine with 3 parts of water acidified with 0.2 per cent. of chemically pure hydrochloric acid.

Diphenylamine.—This is a test for nitrates in plant tissues. Five centigrams of diphenylamine are dissolved in 19 Cc. of pure sulphuric acid. The presence of nitrates is to be assumed when sections treated with this reagent take on a blue color. It seems, however, that in the presence of lignified tissues the reaction may fail, even when nitrates are present in abundance. Diphenylamine is also used to distinguish between crystals of asparagin and potassium nitrate. Asparagin dissolves without color in this reagent, while potassium nitrate assumes a deep blue color on dissolving in it.

Double Staining.—There are certain stains which have a peculiar affinity for

the lignified and suberized or cutinized membranes; others which color the cellulose membranes without affecting the modified membranes, and still others which stain all membranes, but with different degrees of intensity. The latter are known as diffuse stains, and are able to differentiate the tissues when used singly. Thus, safranin will stain the lignified membranes a cherry-red and the unlignified membranes a brownish-red. Double staining by the use of two stains, one of which has an affinity for the modified membranes and the other for the cellulose membranes, gives excellent results in differentiating the tissues. In general, the sections should first be treated with those stains which color the lignified membranes, and then, after rinsing in water or acidulated alcohol, as the case may require, the sections are to come into a stain which has a particular affinity for the cellulose walls. Fuchsin is an excellent stain for the lignified membranes, and hæmatoxylin, aniline blue, methyl blue, and Berlin blue are good stains for the cellulose membranes. Microtome sections should be left in aqueous solution of fuchsin for a quarter of an hour or longer; then they should be washed in a mixture of 1 part of concentrated alcoholic solution of picric acid and 2 parts of water. Then the sections should be placed for about an hour in one of the blue stains above named, and thereafter washed in strong alcohol, transferred to xylol, and thence mounted in Canada balsam. The lignified membranes will be stained red and the cellulose membranes blue. The cutinized and suberized membranes may be stained together with the lignified membranes in the following manner: Ammonia is added to an alcoholic solution of fuchsin until the solution attains a straw-yellow color; then the sections are placed in this and treated thereafter as described for the simple fuchsin solution.

A mixture of fuchsin and iodine green produces an excellent differentiation. One volume of a concentrated aqueous solution of fuchsin is mixed with 9 volumes of a 0.1 per cent. aqueous solution of iodine green. The sections remain in this solution for about eight minutes; then they are washed in a mixture of 100 Cc. of absolute alcohol, 1 Cc. of glacial acetic acid, and 0.1 Gm. of iodine; then transferred to xylol, and thence they are mounted in Canada balsam. The sections should be left longer in the stain if a double stain is not achieved in eight minutes. The proper time for a given material can soon be determined by experiment. In general, those sections stain best which have been fixed in a fixative containing chromic acid or corrosive sublimate. Material which has been fixed in alcohol should, just before staining, be placed for about a day in a 1 per cent. solution of chromic acid, and then washed out in water for some hours. When permanent mounts are to be made, staining is best carried out with sections already fixed to the slide (see page 535).

The iron-hæmatoxylin method of staining imparts different intensities of gray or blue to the different tissues and cell-contents, and is one of the simplest and best differentiating stains. It is particularly useful for staining the dividing nucleus. For staining sections from which photomicrographs are to be made, it is unsurpassed. The method of procedure is as follows: The sections mounted on the slide are placed in a 4 per cent. solution of ferric ammonium sulphate for an hour or so. They are then washed in water and placed in a 0.5 per cent. aqueous solution of hæmatoxylin for an hour or more. The hæmatoxylin solution should be several weeks old. The sections are again washed in water, and placed in 1.5 per cent. solution of ferric ammonium sulphate and left there until examination with the microscope shows that the desired intensity of color is achieved. They are then washed in water, dehydrated in alcohol, cleared in xylol, and mounted in Canada balsam.

The three-color method in which safranin, gentian violet, and orange G are successively employed gives a most beautiful differentiation of the structures of the dividing

nucleus, and in tissues with resting nuclei there is a sharp differentiation of the nucleus, nucleolus, and the cytoplasm, and of the cutinized, lignified, and cellulose membranes. For embryonic tissues this method of staining is unexcelled. It is not, however, so simple as the methods given above, since the time relations of the three stains employed must be accurately determined and adhered to for a given material. This stain works best with material that has been fixed in Flemming's fixative (see page 614), or in a fixative containing chromic acid. Sections from material which has been fixed in alcohol should be immersed for twenty-four hours in a 1 per cent. solution of chromic acid, and then washed in water for a few hours, as above suggested. The sections mounted on the slide are first immersed in a safranin solution which has been prepared by adding to a concentrated alcoholic solution of safranin an equal amount of water. Here the sections remain for twelve hours, or over night. They are then rinsed in pure alcohol, and thereafter immersed in alcohol to which is added about 0.1 per cent. of hydrochloric acid. Just as the clouds of safranin cease to come from the sections, they are rinsed in distilled water and placed in a saturated solution of gentian violet, remaining ten minutes. They are quickly rinsed in water, and while the slide is held horizontally, the sections are flooded with orange G, prepared by diluting a saturated solution of the stain with about five times its bulk of water. After about four seconds the orange G is drained off and the sections are quickly rinsed in water; then, while the slide is held slanting downward, absolute alcohol from a drop-tube is flooded over the slide, beginning at the upper edge of the rows of sections. This washes away some of the surplus gentian violet and dehydrates the sections at the same time. The slide is now again held horizontally and the sections are covered with clove oil from a drop-tube. The process of decolorizing should be watched under the microscope. Clouds of gentian violet come off in the clove oil, and when the stain has passed from an opaque to a transparent color, the clove oil should be drained off and the slide immersed in xylol, where the sections may be further cleared without extracting more of the stain. When the sections appear clear and without any milkiness in the xylol, they may be mounted in Canada balsam under a cover-glass; or they may be first mounted in cedar oil under a cover-glass and examined under high powers to see if the differentiation has been satisfactorily attained in the finer structures. If the gentian violet should be found still too dense, the oil may be washed off in xylol, the xylol rinsed off in alcohol, and the sections again treated with the solution of orange G, alcohol, and clove oil, and thereafter brought into xylol and cedar oil for preliminary examination as before. If, on the other hand, the gentian violet is found to be too faint, the sections should be brought from the oil through xylol and alcohol to the gentian-violet bath for, say, another ten minutes, and then the process onward to the examination in cedar oil should be as at first described. The effect of the orange G is not only to impart its own color to certain of the structures, but to cause the gentian violet, which stains very intensely, to loosen its hold, to a certain extent, from the structures for which it has a special affinity, so that the absolute alcohol and the clove oil may be able to wash out the surplus stain. The critical part of the process is to allow the orange to work long enough to cause the gentian-violet to loosen its hold sufficiently, but not too much. The time relations as above given produce the right result in many instances, but it will be found that they must be altered for certain subjects. In some instances the gentian-violet bath must be prolonged, and in others the orange G solution must be stronger or must be allowed to act for a longer time.

It must be remembered that sections can not be transferred from water or an aqueous stain immediately to xylol or to Canada balsam, for the reason that water does not

mix with these substances. Always, in going from water to oil or a resinous solution, strong alcohol should intervene, and, of course, the same precaution must be taken in going from the oil or resinous solution to water.

Eau de Javelle.—Prepared by adding to an aqueous solution of chloride of lime a solution of potassium oxalate so long as a precipitate is formed. The solution is then filtered and diluted somewhat with water before using. Or 20 parts of a 20 per cent. solution of calcium chloride is diluted with 100 parts of water, and after this has stood for some time, a solution of 15 parts of pure potassium carbonate in 100 parts of water is added. If a film should form on the surface of this on exposure to the air, a few drops of the solution of potassium carbonate should be added and the precipitate filtered away.

Lignin is extracted from sections of woody tissues which have lain in the eau de Javelle solution for some time, and thereafter, on treating with chloriodide of zinc, the membranes show only a cellulose reaction, staining only purple with the chloriodide of zinc.

Starch-grains included in chloroplasts may be demonstrated by first treating sections, or even whole leaves, with eau de Javelle until the chloroplasts are dissolved (this may take from one to twenty-four hours), and then treating the material with a solution of potassium iodide-iodine. The starch-grains will take on a blue or violet color. In some cases, however, the starch-grains themselves are dissolved with the eau de Javelle. In such cases, and indeed in most cases, chloral hydrate and iodine is to be preferred for demonstrating starch-inclusions in chloroplasts (see under this head).

When the forms of the cells simply are to be studied, eau de Javelle is very useful in clearing the sections by dissolving the cell-contents. If the sections become too clear in the eau de Javelle, this defect may be corrected by treating the sections with alcohol or with a solution of alum. See under Cyanin for use of eau de Javelle in differentiating cutinized and suberized membranes.

Eosin.—An aqueous solution of eosin is an excellent stain for protoplasmic cell-contents and cellulose walls. The solution should be quite dilute. For the use of eosin in double staining see under Cyanin and Gram's Method. See also in the next chapter under Aleurone Grains.

Ether.—Used with equal parts of 95 per cent. alcohol as a solvent of collodion; solvent of ethereal and fatty oils.

Fehling's Solution.—Prepare three separate solutions: (1) 17.5 Gm. of copper sulphate in 500 Cc. of water; (2) 86.5 Gm. of sodium-potassium tartrate in 500 Cc. water; (3) 60 Gm. of caustic soda in 500 Cc. of water. To prepare for use mix 1 volume of each of these with 2 volumes of water. The solutions keep well separately, but the mixture becomes changed after a time, and for this reason the solutions should not be mixed until needed.

Sections may be treated with this solution on the glass slip. Two small drops of distilled water are placed on the slip with 1 small drop of each of the three solutions; then sections, not too thin, of the material which is to be tested for glucose are placed in the mixture on the slide. It is best to cut the sections without wetting the razor, and the sections should not be placed in water, but should be transferred directly to the mixture on the slide. The sections should be covered with a cover-glass and the slide carefully heated over the flame of an alcohol lamp, or a very small flame from a Bunsen burner, until bubbles arise in the solution. If glucose is present, the

sections will appear reddish from very small crystals of cuprous oxide which have been reduced from the solution. If it is not desired to observe the crystals of cuprous oxide within the cells, but simply to demonstrate the presence of grape-sugar, small pieces of the tissues to be tested may be placed in a test-tube containing a few cubic centimeters of the solution, which is then heated to boiling; if grape-sugar is present in considerable quantity, a copious precipitate will after a time settle to the bottom of the tube. See under Copper Acetate. This is particularly suitable for demonstrating the presence of grape-sugar in those cells which contained it in the uninjured tissues.

Ferric-ammonium Sulphate.—Used as a mordant. See under Double Staining.

Ferric Chloride.—An aqueous solution is used as a test for tannin. When sections containing tannin are placed in this solution on the slide, a color is produced which may vary from dark blue to green.

Ferricyanide of Potassium.—Used in demonstrating the structure of pyrenoids. Algæ containing pyrenoids are placed in a mixture of equal parts of a 10 per cent. solution of ferrocyanide of potassium and a 55 per cent. solution of glacial acetic acid. Then, after staining with Hofmann's violet and swelling in dilute potassium hydrate, the lamellated structure of the pyrenoids and the included hollow sphere of starch-grains can be distinguished.

Ferrocyanide of Potassium.—A mixture of this salt and hydrochloric acid diluted with 8 to 10 volumes of water is used to stain the nucleus of starch-bearing Characeæ. The starch is changed to sugar by the hydrochloric acid, and Berlin blue is produced, which is taken up by the nucleus, and, after clearing with chloral hydrate, the nucleus becomes plainly visible. See also under Berlin Blue.

Fischer's Method of Demonstrating Cilia.—The following method is highly recommended for demonstrating cilia of certain bacteria: An exceedingly small amount of the culture containing the bacteria is spread out as thinly as possible on the cover-glass. After the film has dried on the cover-glass the latter is passed through the flame of an alcohol lamp or Bunsen burner (care being taken to avoid a too excessive heat), and then a few drops of a mordant are put on the film on the cover-glass. The mordant is prepared by dissolving 2 Gm. of tannin in 20 Cc. of water. The cover-glass is then passed back and forth over a small flame until vapor arises from the mordant. The mordant is now washed off by means of water from a wash-bottle, and then one edge of the cover-glass is held in contact with a piece of filter paper to draw away the surplus water. Next, a concentrated aqueous solution of fuchsin is spread over the film on the cover-glass, and the cover-glass is held over a flame until the fuchsin solution begins to boil; the cover-glass is then washed off, and is allowed to dry. At any time thereafter the cover-glass, with the film side down, may be cemented to the slide with balsam. In successful preparations made by this method cilia, when present, will stand out quite sharply.

Fixatives.—All embryonic plant tissues, and those tissues, whether embryonic or mature, whose protoplasmic cell-contents are to be studied, should be first fixed and hardened preparatory to cutting thin sections from them. The object of fixing is to coagulate the protoplasmic structures in the form which they possessed during life. Subsequent dehydration and hardening prepare the material for imbedding and sectioning.

All the constituents of a fixative should penetrate the tissues quickly and at the same time, and to aid in this the material to be fixed should be cut into the smallest pieces compatible with the purpose of the study (see p. 527).

Absolute alcohol or 95 per cent. alcohol penetrates the tissues quickly, and for

many subjects is an excellent fixative. Material fixed in alcohol does not, as a rule, yield the best results with staining media, and such material should, as already recommended, after sectioning and mounting on the slide, be placed in a 1 per cent. solution of chromic acid for about twenty-four hours, and then washed for two hours in water. Then the sections may be stained.

The best all-around fixative is Flemming's mixture of chromic, osmic, and acetic acids, prepared as described on page 528.

A saturated solution of corrosive sublimate in strong alcohol penetrates quickly, and tissues need to be left in it for only a few hours. The corrosive sublimate should be washed out with alcohol, to which crystals of iodine have been added, until it assumes a brown color.

A concentrated solution of picric acid in alcohol is an excellent fixative for aleurone grains in oily seeds.

It is best to thoroughly wash out all fixatives before the process of hardening in successively higher grades of alcohol is begun. This is accomplished for those fixatives which do not contain corrosive sublimate by washing in running water for about six hours, or over night. Fixatives containing corrosive sublimate should be washed in alcohol containing iodine, as above suggested.

The material to be fixed should be made to sink at once in the fixative. In alcoholic fixatives this will occur very quickly without any special means to accomplish it, but for aqueous fixatives it may be necessary to first pump the air from the tissues. This always insures a better injection of the tissues by the fixative, and is to be recommended for most material. Any sort of air-pump will answer. A bicycle-pump with the valve reversed does excellent service, and has the advantage of portability, so that it may be carried into the field where material may be fixed as gathered. In pumping out the air the material should be immersed in 0.5 per cent. chromic acid if Flemming's fixative is to be used, and after the material has been made to sink in this, the chromic acid should be immediately replaced by the intended fixative. In most aqueous fixatives, such as Flemming's, the material should be left for about forty-eight hours. In the alcoholic fixatives the material may be left from a few hours to twenty-four hours. With some material the best results are obtained by using the fixatives hot. This is true of many sporangias and zygospores, which are very difficult of penetration by the fixative. Since the osmic acid is quite volatile, special precautions must be taken in heating fixatives of which it forms a part. Good results have been obtained in the following manner: The fixative (preferably Flemming's) was poured into a tall test-tube to the height of a few centimeters. Into this was placed the material to be fixed, and the tube was tightly stoppered. Then the test-tube was immersed in a vessel of boiling water to the depth of the fixative, where it remained for about three minutes, or until the fixative began to show signs of boiling; then the test-tube was removed and plunged into cold water. After cooling, the stopper was removed and the material then sank in the fixative. Since the long test-tube extends for some distance above the boiling water, the upper part of the tube remains sufficiently cool to condense the vapors of the fixative as they are formed, and in this way any material change in the composition of the fixative is prevented. The material should remain in the cool fixative for about twenty-four hours, and then should be washed out and dehydrated in the usual manner.

The amount of the fixative employed should always be large in proportion to the material to be fixed in it.

A corrosive sublimate fixative which may be used cold or hot, as the material may require, is prepared by mixing 80 parts of a saturated aqueous solution of corrosive

sublimate with 20 parts of glacial acetic acid. As with all aqueous fixatives, the air pump should be employed when this fixative is used cold.

Fuchsin.—See under Double Staining.

Fuchsin, Acid.—Excellent for staining crystalloids. The material containing the crystalloids should be fixed in a concentrated alcoholic solution of corrosive sublimate. Then the sections should be immersed for twenty-four hours in a 0.2 per cent. solution of acid fuchsin, to which a little camphor has been added. To demonstrate crystalloids in chromatophores the sections should be treated as follows: The sections are placed in a solution of 20 per cent. acid fuchsin in 100 Gm. of aniline-water. This solution is heated somewhat while the sections remain in it from two to five minutes; they are then rinsed in a solution of 1 part of a concentrated solution of picric acid in alcohol and 2 parts of water. This solution should be warmed to about 40° C., and the sections should be rinsed in it until they cease giving off color to it. Thereafter they are dehydrated in strong alcohol, passed into xylol, and mounted in Canada balsam.

Acid fuchsin is an excellent stain for leucoplasts and chromatophores in general. The material is fixed in a concentrated alcoholic solution of corrosive sublimate in absolute alcohol, where the material remains for twenty-four hours; then the fixative is washed out in alcohol containing iodine (see under Fixatives). Sections from this material are placed in a 0.2 per cent. solution of acid fuchsin in distilled water. After remaining twenty-four hours they are taken out, washed in running water for a time, and are then examined in glycerine or are allowed to dry, after which they are mounted in Canada balsam. The sections can not be dehydrated in alcohol, because this will extract the stain from the chromatophores. The following method may also be used: The material is fixed in a solution of 5 Gm. of corrosive sublimate in 100 Gm. of absolute alcohol, which is acidulated with 10 drops of hydrochloric acid. Then the fixative is removed by placing the material in pure alcohol, which is several times replaced. Sections from this material should be stained by immersion for about twenty minutes in a solution of 2 Gm. of acid fuchsin in 200 Cc. of distilled water and 3 Cc. of aniline oil. They are then washed in a mixture of 50 Cc. of a saturated alcoholic solution of picric acid and 100 Cc. of water until color ceases to be given off from the sections. Then the picric acid is washed from the sections in pure alcohol. The sections are next placed in chloroform for ten minutes and are then ready to be mounted in Canada balsam.

When desired, sections cut from fresh material may be fixed and stained as above. Or the material may be fixed and imbedded, and after microtome sections have been cut and mounted on the slide they may be stained as above directed.

A beautiful double stain for nuclei is prepared from acid fuchsin and methyl blue as follows: The microtome sections mounted on the slide are immersed for half an hour in a 0.001 per cent. aqueous solution of acid fuchsin, then quickly washed in water, and immersed for about one minute in a 0.002 per cent. aqueous solution of methyl blue. The surplus stain is then washed off in alcohol and the preparation is allowed to dry; then the sections are immersed in olive oil from six to twenty-four hours, after which they are washed in absolute alcohol or in a mixture of absolute-alcohol and xylol until the stains are quite clear, and the preparation is ready to be mounted in Canada balsam.

Gelatine.—Motile swarm spores and the like are sometimes mounted for observation in a solution of gelatine, which renders their movements less rapid, and in this way facilitates the study of these bodies. About 1 Gm. of gelatine is dissolved

in 100 Cc. of water; a drop of this is placed upon a slide which has been somewhat warmed, and then a drop of the fluid containing the motile bodies is added to the drop of gelatine solution and mixed with it by stirring, after which the cover-glass is put on. See also under Nutrient Media.

Gentian Violet.—A 1 or 2 per cent. solution of acetic acid, to which gentian violet is added until the solution appears of a deep violet color, is effective in instantaneously fixing and staining the nuclei of fresh tissues. Anthers and sporangia need only to be teased out with needle in this fluid or crushed under the cover-glass, when the nuclei of the pollen-grains and spores or the mother cells of these will be fixed and stained for immediate examination. See also under Double Staining and Gram's Method.

Glucose.—A mounting medium is made from glucose by mixing 140 parts of distilled water with 10 parts of camphorated alcohol, 40 parts of glucose, and 10 parts of glycerine. The water, glucose, and glycerine are first mixed, and then the alcohol is added and the mixture filtered to remove any camphor which may have been precipitated. The aniline stains are preserved particularly well in this medium.

Glycerine.—This is frequently used as a mounting medium, but since objects are apt to become very transparent in it, only those sections which have been stained should be mounted in it. Sections, such as of wood, which are not apt to shrink easily may be mounted in glycerine directly from water, but delicate tissues should first go from water into a mixture of 10 parts of water and 1 part of glycerine; this should then be allowed to concentrate by the evaporation of the water, when the sections may be mounted on the slide in a drop of pure glycerine. The cover-glass should be quite clean and the glycerine should not be allowed to run back over it. After putting on the cover-glass the surplus glycerine should be taken up with a bit of filter paper and the slide about the edge of the cover-glass should be made quite clean with a cloth moistened in water and then wiped dry with a dry cloth; then the slide may be put in position on the turntable, where a ring of Brunswick black, or of shellac to each ounce of which 20 drops of castor oil have been added, may be spun around the edge of the cover-glass. This process should be repeated several times, allowing each coat to harden before putting on the next, until a strong ring of the cement has been formed. When certain stains are used, such as hæmatoxylin, the glycerine must be entirely free from acids; but with other stains, such as the carmine stains, an acidulation with 1 per cent. of acetic acid is of advantage.

Dilute glycerine, in which sufficient chrome-alum has been dissolved to give a clear blue color, is recommended as a mounting medium for the Schizophyceæ and Florideæ, since the natural colors of these plants are retained in this medium.

Sections containing mucilaginous membranes may be mounted in a drop of pure glycerine in which the membranes will not swell, and then, by irrigating the mount with water, the process of the slow swelling of the membrane may be observed.

Glycerine-gelatine.—This is for most subjects a better mounting medium than glycerine alone. It is prepared as follows: One part by weight of the best gelatine is soaked for about 2 hours in 6 parts by weight of distilled water. Then 7 parts by weight of chemically pure glycerine are added, and finally, to each 100 Gm. of this mixture 1 Gm. of concentrated carbolic acid. The mixture is warmed for about 15 minutes, and at the same time constantly stirred until it becomes clear; then, by means of a hot-water funnel, or while kept warm in an incubator, the mixture is filtered through glass-wool or filter paper which has been washed with distilled water after being placed in the funnel.

To mount sections in glycerine-gelatine the glass slip is warmed and a small bit

of the gelatine is placed upon it. If the slip is not warm enough to melt the gelatine, it should be passed back and forth above the flame of an alcohol lamp. If the sections are of a character not liable to shrink, they may be transferred directly from water to the melted gelatine; if, however, there is danger of shrinking, the sections should first be placed in a 10 per cent. solution of glycerine, which is then allowed to concentrate by evaporation of the water, and then, from the concentrated glycerine the sections may be transferred to the drop of melted glycerine-gelatine. To avoid air-bubbles the cover-glass should be put on with the precautions given on page 532 for putting on the cover-glass when Canada balsam is the mounting medium. If several sections are being mounted under one cover-glass, and these should come to lie over each other in putting on the cover-glass, they may be properly arranged without attempting to remove the cover-glass (which usually makes the matter worse) by heating the slide until the gelatine becomes quite soft, and then drawing a hair under the cover-glass, with which the sections may be manipulated. It is sometimes a difficult matter to put just the right amount of the gelatine on the slip. To overcome this difficulty, heat the gelatine and pour it out in a thin film over a clean glass plate. When it has become cool, strip it from the glass; then cut off small squares of different size, melt them separately on glass slips, and cover with the cover-glasses of the size to be used with subsequent preparations. The film of gelatine should then be cut into wafers of the size found to exactly fill out the space under the cover-glass. These wafers should be kept from drying too much and free from dust in tightly stoppered bottles.

Glycerine Gum.—For imbedding brittle objects see p. 535.

Gold Chloride.—Protein crystalloids may be beautifully stained by means of a solution of gold chloride. The material is to be fixed in a 20 per cent. solution of corrosive sublimate in absolute alcohol, then the fixative is to be washed out in alcohol containing iodine, and finally in pure alcohol; and then the sections are to be placed in a 1 per cent. solution of gold chloride for about 3 hours. This process is to be carried on in the dark. Then the sections are to be placed in a 5 per cent. solution of formic acid, in which they are to remain for several hours exposed to the light. They are next to be placed in 10 per cent. glycerine, which is allowed to concentrate in a place free from dust, and from the concentrated glycerine they are to be mounted in glycerine-gelatine, under which head will be found the method of mounting. By this method of staining, the crystalloids are stained from rose to violet.

The above method also works admirably in the demonstration of leucoplasts.

Gold Size.—An excellent cement for sealing glycerine mounts, and when immersion lenses are to be used, since this cement is not soluble in the immersion oil. Best obtained already prepared from the dealers.

Gram's Method.—This method is specially recommended for staining bacteria, either in cover-glass preparations or in sections. The sections are stained in a mixture of 100 Cc. of aniline water (prepared by combining about 5 Cc. of aniline with 95 Cc. of distilled water), and 11 Cc. of a concentrated alcoholic solution of gentian violet, or, better, methyl violet. This is filtered, and 10 Cc. of absolute alcohol are added to it. The preparation is taken from the stain, rinsed in alcohol, and transferred to a solution of 2 parts of potassium iodide, and 1 part of iodine in 300 parts of distilled water, where it remains from 1 to 3 minutes. Then it is rinsed in alcohol, transferred to clove oil, and thence mounted in Canada balsam. A good double stain is obtained if the clove oil has some eosin dissolved in it.

Gunther's modification of the Gram method is as follows: The preparation is stained and passed through the potassium iodide-iodine solution as above. Then

it is placed for 1 to 2 minutes in alcohol, next for 10 seconds in a 3 per cent. solution of hydrochloric acid in alcohol, then again for several minutes in pure alcohol, until no more color comes away, and then it is passed on into xylol, and finally is mounted in Canada balsam.

Gum Arabic.—The study of the spermatozoids of ferns, etc., is facilitated by adding a 10 per cent. solution of gum arabic to the drop of water containing the spermatozoids, which are then unable to move so rapidly in the thicker fluid.

Hæmatein.—Dissolve with heat 1 Gm. of hæmatein in 50 Cc. of 90 per cent. alcohol, and add to this a solution of 50 Gm. of alum in 1 liter of distilled water. After cooling, filter if necessary, and add a crystal of thymol to prevent the growth of fungi. The solution is ready for use at once. Sections stained in this solution should be washed in water and transferred to glycerine-gelatine for mounting, or may be dehydrated and mounted in Canada balsam. The stain may be reduced in overstained sections by allowing the preparation to stand for some time in a 1 per cent. solution of alum. A sediment is apt to settle from this solution, but this is not an indication that the stain is spoiled. The sediment can be partly prevented by adding to the solution about 2 per cent. of glacial acetic acid, which, on the whole, increases the effectiveness of the stain. The acid should be entirely washed from the sections with water before permanent mounts are made.

Hæmatoxylin, Delafield's.—Prepared by mixing 4 Cc. of a saturated solution of hæmatoxylin crystals in absolute alcohol with 150 Cc. of a saturated solution of crystals of ammonium alum in water. After standing for a week exposed to the light, this should be filtered and mixed with 22 Cc. of glycerine and 25 Cc. of methyl alcohol. Before using this it should be allowed to stand until all precipitates have settled.

Hæmatoxylin and Eosin.—These may be combined to form a double stain by adding the above solution to a mixture of equal parts of glycerine and a saturated alcoholic or aqueous solution of eosin, until the green fluorescence of the eosin has entirely disappeared.

Hæmatoxylin and Safranin.—Sections stained in safranin and washed in water may be placed for a few minutes in a solution of 0.1 Gm. of alum in 30 Cc. of water to which have been added a few drops of a solution of 3.5 Gm. of hæmatoxylin in 100 Gm. of alcohol. The hæmatoxylin and alum mixture should stand a few days before using. By this treatment lignified and suberized walls are stained red and cellulose walls violet.

Hanging-drop Culture.—A hanging-drop culture is useful in the study of various micro-organisms. A glass or vulcanite ring, obtained of the dealers for the purpose, is cemented to the ordinary glass slip with Canada balsam or melted paraffin. A round cover-glass, which should have a diameter at least as large as the outside diameter of the ring, should be thoroughly cleaned, and sterilized by baking in a hot-air sterilizer. Then the slide may be held with sterilized forceps, or placed on any convenient support, while a drop of nutrient substance is placed on the cover-glass by means of a sterilized glass rod. By means of a sterilized platinum needle a few individuals of the organisms to be studied may be transferred from pure cultures to the drop of nutrient fluid on the slide. Then the cover-glass should be quickly inverted over the ring cemented to the glass slip, the upper surface of the ring having been previously lightly coated with vaseline, which serves to hold the cover-glass in position and, at the same time, prevents the drop from evaporating. If a single organism is desired in the hanging drop, a few of the organisms from a pure culture may be trans-

ferred by means of a sterilized platinum needle to some sterilized nutrient liquid in a test-tube; the tube should be twirled between the palms of the hands to distribute the organisms, and then a drop from the test-tube should be transferred to the cover-glass. More organisms should be transferred from the pure culture to the test-tube, or more nutrient liquid should be added to that already in the test-tube, until it is found that a single individual of the organism to be studied occurs in each drop taken from the test-tube. If, in inverting the cover-glass over the ring, the drop runs to one edge or spreads out over the cover-glass so that it comes in contact with the ring, the cover-glass is to be washed off and the process repeated until the drop hangs free near the center of the cover-glass. The drop must not be so large that if the organism should sink to the lower surface of the drop it could not be brought into focus with the highest power objective to be used in studying it. The circulation in the plasmodia of myxomycetes may be conveniently studied if a bit of the substratum containing the plasmodium is moistened and placed on the cover-glass, which is then inverted over the ring as before. The preparation is then set aside in a warm, dark place until the plasmodium has grown out over the cover-glass.

It is sometimes of advantage to place a drop of water on the glass slip within the ring, so that the atmosphere within the cell will be kept quite humid. Instead of the glass or vulcanite ring, thick cardboard may be used. A piece is cut 1 inch square, if the glass slip is 3 x 1 inch, and a round or square hole is cut in the center of the cardboard somewhat smaller than the cover-glass to be used. The cardboard is sterilized in boiling water, and pressed into position on the slide. The hanging-drop culture is prepared as above described, but no medium is needed to fasten the cover-glass to the cardboard, other than the water with which the cardboard is soaked. Thereafter the cardboard should be moistened from time to time as needed. Bits of the plasmodia of myxomycetes, when suspended on the cover-glass of such a cardboard cell or of the glass or vulcanite cell, as above described, will grow out over the cover-glass, and may be studied throughout a protracted period without being disturbed. If a solid nutrient medium is required, a drop of nutrient gelatine may be placed on the cover-glass instead of the drop from the fluid nutrient medium. Under certain circumstances it is of advantage to flatten out the drop of nutrient substance, after the organisms have been planted in it, by placing over it a smaller cover-glass, which, of course, should be so small that when the larger cover-glass is inverted over the ring or piece of cardboard, the border of the smaller cover-glass will not come in contact with the inner edges of the cell.

Hardening Processes.—The hardening of tissues is accomplished by the withdrawal of water from them. This is, in most cases, best accomplished by means of successively higher grades of alcohol, as described elsewhere.

A quick method of hardening fresh tissues, and at the same time preparing them for immediate sectioning, is to freeze them by the evaporation of ether or the expansion of liquid carbonic-acid gas. This process requires the use of special apparatus, for a description of which the student is referred to the catalogue of Bausch and Lomb, Rochester, N. Y. For an imbedding mass, either a drop of the white of egg, or a thick solution of dextrin in a solution of carbolic acid, 1 part, water 40 parts, may be placed about the object before freezing. If the dextrine solution is used, it would be better to pump the air from the object while immersed in the solution; then place on the object-holder, pour a small amount of the solution about it, and freeze. This method will answer very well in some cases, when it is desired to prepare a large number of sections quickly for class use, but it can by no means take the place of fixing the material in an appropriate fixative, hardening slowly in alcohol, and imbedding in paraffin or collodion.

The mucilaginous layer of certain seed coats may be hardened with a 10 per cent. solution of neutral acetate of lead. The sections are cut from dry seeds, hardened in the lead acetate, and stained with methyl blue. They are then washed in water and mounted in a 2 per cent. solution of boracic acid.

Hydrochloric Acid.—This reagent has such manifold application in histology that its uses are best learned in the specific cases of its application. See in the next chapter under Amylose, Berberin, Caffeine, Calcium Oxalate, Calcium Sulphate, Ethereal Oils, Elæocapsin, Magnesium Sulphate, Middle Lamella, Myrosine, Pectic Substances, Phloroglucin, Theobromine, Vanillin. See also in this chapter under Maceration.

Hydrogen Peroxide.—One part of hydrogen peroxide mixed with 20 parts of 60 per cent. alcohol will, in a few minutes, remove from sections the dark discoloration due to osmic acid which has been used as a fixative (see p. 528).

India Ink.—The gelatinous sheath of the conjugatæ may be demonstrated by placing the alga under investigation in water in which India ink has been rubbed up until the water has a dark gray color. In this the gelatinous sheath becomes sharply demarked.

Infiltration.—For infiltration with glycerine gum see page 527, with paraffin, page 529, with collodion, page 534. The stony tissues of seeds, etc., which are too hard and brittle to be sectioned with a knife, and must, therefore, be ground to the requisite thinness on a stone or by means of emery powder, may be protected against breaking during this process if fairly thin sections are first cut with a fine saw and then placed in a rather thin solution of Canada balsam or copal in chloroform, which is then allowed to evaporate to the thickness of syrup; the sections are allowed to dry and are then cemented by means of a thick solution of gum arabic to a glass plate preparatory to grinding. Only a thin layer of gum arabic should be used, and this should be quite dry before the grinding is begun. The sections may now be ground thin on a clean, dry Arkansas or Wichita stone. Before the section has been brought to the desired thinness, the surface should be polished by rubbing it on a piece of soft leather which has been dressed with tripoli. The stone on which the sections are ground may be cleaned of the balsam from time to time by means of a cloth dipped in xylol or turpentine. When one side has been polished, the section may be freed from the glass plate by soaking in water, and then the polished side should be cemented to the glass plate and the reverse side ground and polished as before. The sections should be examined from time to time with the microscope, so that the process of grinding may be stopped as soon as the desired transparency has been obtained. They may then be washed from the glass plate with water, and after drying should be mounted in Canada balsam.

Iodine.—The fumes from heated crystals of iodine serve well in many cases as a fixative. Small objects in drop cultures may be readily fixed by pouring over them the fumes arising from iodine heated in a test-tube. Algæ may be fixed by placing a few crystals of iodine in the bottom of a test-tube, cautiously inclining the tube slightly with the mouth downward, then pacing the algæ in the test-tube near the mouth directly from the water in which they were growing, and thereafter heating the crystals so that the fumes from them pour down over the algæ. The iodine may afterward be expelled by warming the fixed material to 30° or 40° C., and the material will then need no further washing out.

Iodine has a wide application in plant histology and microchemistry. See under Aconitine, Atropine, Carotin, Cellulose, Colchicine, Gums, Gram's Method, Lipochromes, Lignin, Mucus-globules, Nicotine, Proteids, Suberin.

Iodine and Alcohol.—A good fixative for very small organisms is a solution of 3 parts of iodine in 100 parts of 70 per cent. alcohol. This, at the same time, permits the staining effect of iodine on the cell-wall and cell-contents.

Iodine and Aluminum Chloride.—Aluminum is dissolved in hydrochloric acid to saturation, and then allowed to evaporate to the consistence of syrup. Cellulose is colored a dark blue to violet color when successively acted on by this reagent and a solution of potassium iodide and iodine. It is said to act more quickly than chloro-iodide of zinc and iodine and the color imparted is retained for several days.

Iodine and Glycerine.—A mixture of potassium iodide-iodine with glycerine in equal parts gives good results when the action of iodine is to be observed. The glycerine keeps the preparation from drying, and at the same time has a clearing effect.

Iodine and Phosphoric Acid.—Used as a test for cellulose, which it colors violet. Prepared by dissolving with heat 0.5 Gm. of potassium iodide and a few crystals of iodine in 25 Cc. of concentrated aqueous solution of phosphoric acid.

Iodine and Potassium Iodide.—This solution is prepared by dissolving 0.5 Gm. of potassium iodide and 1 Gm. of iodine in a small amount of water, and then diluting this with 100 Cc. of water. The solution is left standing over any iodine which may crystallize out. This formula is recommended by Arthur Meyer in his work on "Stärkekörner" as best adapted to the study of starch-grains. A rough-and-ready method of preparing an iodine solution is to dissolve a small amount of potassium iodide in distilled water and then dissolve crystals of iodine in this until a brown color is obtained. This can be diluted with water as is found necessary. A rather pale solution of iodine is sufficient to color starch blue. To stain modified cell-walls the solution needs to be stronger.

Iodine and Sulphuric Acid.—A test for cellulose. The section is first soaked in a solution of potassium iodide-iodine, and then is mounted in a drop of a mixture of 2 parts by volume of sulphuric acid and 1 part of water. Cellulose walls take on a blue color by this process.

Iodine Green.—See under Double Staining. A 2 per cent. solution of glacial acetic acid with iodine green dissolved in it serves well in the instant fixing and staining of the nuclei of fresh material.

Iron Acetate.—Used in the detection of tannins, which see.

Iron Hæmatoxylin.—See Double Staining.

Lactic Acid.—Dried algæ and fungi may be prepared for study with the microscope by soaking them first in water and then in concentrated lactic acid, in which they are heated until small bubbles are formed; they may then be studied in the lactic acid. A 10 per cent. solution of lactic acid is recommended for fixing bacteria. This fixative is said not to interfere in any way with the subsequent processes of staining with alcoholic solutions of aniline dyes.

Lead Acetate.—A 10 per cent. solution of neutral lead acetate is used to harden the mucilaginous layers of seed coats. For subsequent treatment see under Boracic Acid.

Lithium Carbonate.—Useful in removing from material picric acid, which has been used as a fixative. A few drops of a cold, saturated, aqueous solution of lithium carbonate are added to the alcohol, which is used to wash out the fixative.

Maceration.—The study of the forms of cells is greatly aided by isolating the cells from each other by the process known as maceration. Various reagents may

be used for this purpose. A solution of potassium chlorate in nitric acid is very commonly employed. This is known as Schulze's maceration fluid. A few pieces of potassium chlorate are put into a test-tube, where they are covered with nitric acid; not very thin longitudinal sections of the material to be macerated are put into the solution, which is then gently heated over a Bunsen burner until bubbles are violently evolved. After standing for a short time the contents of the tube are poured into a vessel containing considerable water. The sections should be transferred to a second dish of water, and then mounted in a drop of water, as needed for examination. The cells may easily be separated from each other by teasing out the section in the drop of water with two dissecting needles. The cells may be isolated from each other by this treatment, for the reason that the middle lamellæ are dissolved, and only the membranes due to secondary thickening remain. The lignin is also removed from the lignified membranes, so that these after maceration give only a cellulose reaction. All chemical manipulations involving the evolution of acid fumes as above should be carried on where the fumes may be quickly conducted out of the laboratory, since the fumes are not only irritating to the mucous membranes, but they are also injurious to delicate apparatus, such as compound microscopes.

Chromic acid may be used for maceration instead of Schulze's maceration fluid. A concentrated aqueous solution is used, and in this the sections are allowed to remain for about half a minute, when they are to be rinsed in plenty of water. They are then to be teased out in a drop of water as before. Very thick sections can not be treated by this method.

Schulze's maceration fluid is to be particularly recommended for sections containing lignified tissues, while tissues destitute of lignified membranes, or containing only a small percentage of these, may be better macerated as follows: A mixture is made of 1 part of hydrochloric acid and about 4 parts of alcohol. The sections remain in this mixture for about twenty-four hours; then they are washed in water, and mounted in a 10 per cent. solution of ammonia. A slight pressure on the cover-glass will assist the cells in separating from each other. Cork-cells can be macerated to best advantage by means of a dilute solution of potassium hydrate. See also under Acetic Acid.

Magnesium Sulphate and Ammonium Chloride.—A mixture of 25 volumes of a concentrated aqueous solution of magnesium sulphate, 2 volumes of a concentrated aqueous solution of ammonium chloride, and 15 volumes of water is used as a test for phosphoric acid in tissues. When sections containing salts of phosphoric acid are treated with this reagent, a crystalline precipitate of ammonium magnesium phosphate is formed.

Mercuric Chloride.—Used as a fixative in both aqueous and alcoholic solutions. An aqueous solution which has given excellent results is composed of 80 parts of a saturated aqueous solution of mercuric chloride in water and 20 parts of glacial acetic acid. See also under Fixatives.

Methyl-alcohol.—The refractive index of methyl-alcohol is 1.321, being less than that of water, which is 1.336. On account of this low refractive index methyl-alcohol is a good mounting medium for bringing out the striation in starch-grains and cell-walls.

Methyl-blue.—An excellent stain for cellulose membranes. For double staining, the sections may first be stained with safranin, then washed with alcohol and placed in a concentrated aqueous solution of methyl-blue for 15 minutes or longer. The sections are then to be washed in strong alcohol and mounted in Canada balsam. See also under Double Staining.

Methylene-blue.—A good nuclear stain. For cells filled with protein granules it is particularly good in differentiating the nucleus. Methylene-blue is useful in differentiating pectin compounds. The protoplast and lignified walls are stained a bright blue, while pectin compounds are stained a violet blue. Cells containing tannin will accumulate methylene-blue from very dilute solutions. The sections of living tissues are placed in a solution of 1 part of the stain in 500,000 parts of filtered rain-water. The cells containing tannin soon take on a distinct blue color, and, later, a deep blue precipitate is formed in them. The gelatinous sheaths of live conjugatæ may be stained by dilute aqueous solutions of methylene-blue without injury to the living organism. A 0.001 per cent. solution of methylene-blue in water will stain the living nuclei of diatoms and other simple organisms. The central body of the Cyanophyceæ may be stained by the above dilute solution if, after 24 hours' treatment, the stain is strengthened to a 0.1 per cent. solution. Methylene-blue and carmine form a good differential stain for bacteria occurring in sections of tissues.

Methylene-blue and Carbol-fuchsin.—This double staining method is used in the differentiation of Bacillus tuberculosis. The material first coughed up from the lungs by the patient on waking in the morning should be expectorated into a wide-mouthed bottle or covered jar. The person who is to make the examination should afterward pour this out into a shallow glass dish. This should be placed on a dead-black background, and one of the small, yellowish, lenticular bodies which usually occur in tuberculous sputum should be removed and placed on a cover-glass. A second cover-glass should be placed over this; then press the cover-glasses gently between the thumb and forefinger, and rub to and fro until the material is spread out in a thin film on the cover-glasses. Then slide the cover-glasses apart, and allow them to dry in the open air. When dry, hold them with a pair of forceps and pass them 3 times through the flame of the Bunsen burner or alcohol lamp. (The film should not be allowed to turn brown, else the preparation will be ruined.) Next pour over them carbol-fuchsin prepared by rubbing 1 Gm. of fuchsin with 100 Cc. of a 5 per cent. aqueous solution of carbolic acid, with the gradual addition of 10 Cc. of alcohol. Hold the cover-glasses over a flame with forceps until vapor begins to arise from the surface of the stain. Then hold away from the flame, except in intervals of gentle heating, by which they are kept warm for a minute or two. They are next washed in water and decolorized by being moved about in a 25 per cent. solution of nitric or sulphuric acid. When the previously deep-red color has changed to a greenish tint, the preparation is washed in 60 per cent. alcohol to remove the color set free by the acid. If any red color still remains, the preparation should be rinsed in water and again treated with the acid-bath. By the above process the fuchsin has been removed from everything but the tubercle bacilli. The double staining is accomplished by now pouring over the preparation a mixture of 3 parts of water with 1 part of a concentrated alcoholic solution of methylene-blue. After a few minutes the methylene-blue is washed off with water, and the preparation is allowed to dry; when dry, it may be mounted in Canada balsam. Other bacteria than the tubercle bacilli are decolorized by the acid-bath, and are subsequently stained blue by the methylene-blue.

Methyl-green.—An aqueous solution of this stain serves well to differentiate the nucleus of cells containing aleurone grains. Sections through vascular bundles which have been treated for some hours with alcohol borax-carmine, and then for a short time with methyl-green, have the protoplasmic cell-contents stained red, the lignified walls of the tracheal tubes green, and the walls of the primary phloëm portion green.

Methyl-green and Acetic Acid.—Methyl-green is dissolved in a 2 per cent.

solution of acetic acid until the solution has a blue-green color. The nuclei of fresh material teased out in this become instantly fixed and stained. It is very useful for a preliminary examination of dividing nuclei.

Methyl-violet.—Starch-grains may be stained by treatment with a dark aqueous solution of methyl-violet. If the starch-grains after staining are treated with a very dilute solution of calcium nitrate, the stain becomes deposited particularly in the less dense layers of the grains. Useful as a stain for elaioplasts. See under this head in the next chapter, page 640. See also in this chapter under Staining Intra Vitam.

Millon's Reagent.—This should be prepared fresh, as needed, by dissolving mercury in an equal weight of nitric acid and then diluting this solution with an equal weight of distilled water. Proteids are colored a brick-red with this reagent. Sections to be tested are to be mounted in a drop of the reagent on a glass slip. Warming the slip hastens the reaction.

α-**Naphthol.**—When sections which are rather thick are treated on a slide with a drop of a 20 per cent. aqueous solution of *α*-naphthol and then two or three drops of concentrated sulphuric acid are added, the sections will be colored violet in a few minutes if cane-sugar, milk-sugar, glucose, lævulose, maltose, or inulin is present.

Nessler's Reagent.—Used as a test for the presence of ammonium. Prepared by dissolving 2 Gm. of potassium iodide in 5 Cc. of water, and then adding mercuric iodide to the solution while warm until a part remains undissolved. After cooling, 20 Cc. of water are added to the solution and then, after standing for a time, the solution is filtered, and to each 20 Cc. of it are added 30 Cc. of a concentrated solution of caustic potash. The solution must be filtered as often as it becomes turbid. The solution is changed to a yellow color in the presence of ammonia. However, other organic compounds may give the same reaction.

Nutrient Media.—Nutrient media must be sterilized by heat to keep them from spoiling and to make it possible to grow in them pure cultures—that is, cultures of organisms of any desired single species. Sterilization may be accomplished by steaming the medium for about twenty minutes each day on three days in succession, after having poured it into test-tubes or flasks which have previously been tightly plugged with cotton rolled into the form of a stopper of the proper size and baked in an oven until the cotton is slightly scorched. The tubes and cotton plugs should be baked together. Or, if an autoclav is available in which steam can be generated under pressure, and accordingly at a higher temperature than that of boiling water at ordinary atmospheric pressure, the cotton plugs and tubes, or flasks, will not need to be baked but may be sterilized, together with the nutrient medium already poured into them, by subjecting them for fifteen minutes to a temperature of 115° C. in the autoclav. At this temperature a single sterilization suffices.

A good artificial nutrient medium for yeasts is made by adding 0.05 per cent. of tartaric acid to a 10 per cent. solution of cane-sugar. A filtered aqueous extract of malted barley also gives good results. To prepare this, barley is germinated until the plumule just begins to protrude; the barley is then dried and ground up, and water is poured over it until there is about twice as much water by volume as of the powdered malt. The water should stand over the malt, with occasional stirring, for about an hour, when it may be filtered off and sterilized. Sterilized grape juice is also an excellent nutrient medium for yeasts. Cultures of yeasts grown in the above media may be made to produce spores in about twenty-four hours if some of the culture is transferred to the surface of sterilized bits of flower-pots which are half submerged in water and kept covered by a bell-jar.

Cohn's normal solution for the culture of bacteria is prepared as follows: Dissolve in 200 Gm. of distilled water 1 Gm. of acid potassium phosphate, 1 Gm. of magnesium sulphate, 2 Gm. of neutral ammonium tartrate, and 0.1 Gm. of calcium chloride.

An infusion of meat for the culture of bacteria is prepared by covering finely chopped lean beef with water and allowing it to stand for twenty-four hours in an ice-chest, after which it is to be filtered through a muslin bag, using pressure of the hands to make the filtration more complete. The filtrate is then cooked and again filtered, and neutralized by the gradual addition of a solution of carbonate of soda. The solution should be tested with litmus paper, and the addition of carbonate of soda should cease as soon as neutralization is accomplished. To this solution is added 0.5 per cent. of common salt. Ten Gm. of peptone may be added to a liter of the infusion.

In place of the meat infusion as prepared above, meat extract may be used in the ratio of 4 to 5 Gm. per liter of water.

Bouillon is prepared by adding 1 liter of water to 1 pound of chopped lean beef. This is cooked for half an hour, then filtered and neutralized with carbonate of soda, then again boiled for an hour to precipitate albuminoids. After a final filtering the bouillon is poured into flasks or test-tubes and sterilized.

Infusions of hay and dried fruits may also be used for nutrient media. A hay infusion for the growth of Bacillus subtilis may be prepared as follows: Chopped hay is placed in a beaker and barely covered with well water; this is kept in an incubator at a temperature of 36° C. for four hours, after which time the extract is poured off and diluted, if necessary, to a specific gravity of about 1.004. The extract is now poured into a flask which, having been closed with a cotton plug, is placed in a steam sterilizer and subjected to a gentle evolution of steam for about an hour. The flask is then placed in an incubator at 36° C. for a day or two, after which time a film produced by colonies of Bacillus subtilis will have formed over the surface of the extract. The spores of this bacterium are particularly resistant to heat, and for this reason while the spores of other bacteria are killed by the process of steaming, those of Bacillus subtilis still retain their vitality.

Solid culture media may be prepared by adding to any of the fluid culture media a sufficient amount of a gelatinous substance to keep the mixture from liquefying at the temperature of the laboratory or, if desired, at the higher temperature of an incubator. One of the most used of the solid media is prepared by adding to the peptonized infusion of meat, as above described, 10 per cent. of the best French gelatine. The gelatine may be increased up to twice this amount, as the temperature may require. One hundred grams of gelatine is allowed to soak in 1 liter of the meat infusion until the gelatine becomes swollen, and then a gentle heat is applied until the gelatine is completely dissolved. After the gelatine is dissolved the solution should again be neutralized, if necessary, with carbonate of soda. When the solution stands at a temperature of about 50° C., an egg stirred up in 100 Gm. of water is added while the mixture is stirred with a glass rod. The mixture is then kept at the boiling-point for about ten minutes. This coagulates the egg-albumen and clarifies the liquid. The clarified liquid is now filtered by means of a hot-water funnel or while kept warm in an incubator, the high temperature being necessary for the reason that the mixture would become stiff at a low temperature, and so incapable of being filtered. The medium should be distributed while warm in sterilized test-tubes or flasks, which are then stoppered with baked cotton plugs. It should then be subjected to a temperature of 100° in the steam sterilizer for 10 minutes at 4 successive intervals of 24 hours. For the reason that gelatine loses its power of solidifying at ordinary tem-

peratures after being subjected to the temperature of boiling water for a long period, the time of each sterilization is necessarily reduced to about 10 minutes and the number of sterilizations is increased to 4; whereas with other solidifying substances, such as agar-agar, the length of each sterilization may extend to 1 hour, and the number of sterilizations need be only 2 or 3.

In pouring the filtered medium into the test-tubes care should be taken not to get any of the medium on the upper portion of the tube where the cotton plug would be likely to come in contact with it, else the plug would later be difficult of removal.

A solid nutrient medium which will remain solid at a higher temperature than the gelatine medium may be prepared from agar-agar, a substance obtained from certain gelatinous algæ, as follows: Two Gm. of the agar are broken into small pieces and soaked in cold water for 24 hours. Then the water is poured off and the swollen agar is added to 1 liter of the peptonized meat infusion. The mixture is boiled for several hours until the agar is completely dissolved. The solution is then neutralized with a solution of carbonate of soda, filtered, distributed in flasks or test-tubes, and sterilized by steaming for 1 hour at 2 or 3 successive intervals of 24 hours.

Cooked potatoes afford a solid nutrient medium which is quickly prepared and which is particularly adapted for the culture of chromogenic bacteria. Potatoes free from wounds are selected and scrubbed in water until they are perfectly clean, and the eyes and any unsound spots, if these could not be avoided, are cut out with a knife. Then the potatoes are placed for an hour in a solution of 1 part of mercuric chloride in 500 parts of water to disinfect the surface. They are next steamed for about an hour in a steam sterilizer, and after 24 hours the steaming is repeated for about half an hour. The sterilized potatoes are then placed in glass Petri dishes, are cut in halves with a sterilized table-knife, and the cut surfaces are inoculated. If the source of the inoculation is not a pure culture, an isolation of forms may be approximated by making long scratches over the surface of the potato with a sterilized platinum needle which has been in contact with the source of the inoculation. It will add to the security of the process of sterilization if each potato, before being placed in the bath of mercuric chloride, is wrapped in a piece of tissue paper, and so protected until it is cut open for inoculation.

Another method of preparing potatoes which is, on the whole, more convenient and certain, is to cut out long cylindrical plugs from sound potatoes by means of a cork-borer or any metal tube of the proper size, and then to cut the potato cylinders very obliquely in two pieces, each of which is then to be placed in the bottom of a test-tube so that the oblique surface stands uppermost. After plugging the tubes with baked cotton, the potato cylinders are subjected to a temperature of 100° C. in the steam sterilizer for one hour at three successive intervals of 24 hours. A sterilized paste made from potatoes or bread serves well for the culture of molds as well as of bacteria.

A decoction of horse-dung furnishes a good medium for the culture of mucor and various other molds. The decoction is prepared by boiling the dung in water, then filtering and sterilizing the solution. By placing the dung of different kinds of animals in a moist chamber, as, for instance, in dishes floating on water and covered with a bell-jar, characteristic fungi will after a time appear on it.

Single spore cultures of mucor may be obtained in the following manner: Glass slides are thoroughly cleaned and sterilized by baking. By means of sterilized forceps a single sporangium of mucor is picked from a spontaneous growth of this fungus on horse-dung or stale bread kept in a moist chamber. The sporangium is placed in a sterilized decoction of horse-dung contained in a sterilized watch-glass, which

may be placed on an inverted tumbler in a plate of water and then covered with a bell-jar which should dip into the water and form a germ-proof moist chamber. After a few hours the sporangium will have burst open and the spores, which are now distributed through the decoction, will have swollen to several times their original diameter, and can all the more readily be discerned in subsequent manipulations. A needle which has been disinfected by heating in a flame is now dipped into the decoction and the point of it drawn along the surface of a glass slide which has been cleaned and sterilized as above directed. By this process the decoction which has adhered to the needle is drawn out in the form of a narrow streak, and if several spores of mucor are present, they will be separated from each other. A single spore may be located with a medium power of the compound microscope, and all other spores present in the streak may be wiped off with a cloth which has been sterilized by heat. Then a drop of the decoction of sterilized horse-dung should be added to the small amount containing the spore on the slide. The slide should be placed in a moist chamber where the spore will soon give rise to a mycelium visible to the naked eye, and from the mycelium numerous sporangia will be produced after a time. The slide may be taken from the moist chamber from time to time and the stages in the development of the fungus examined, but as much care as possible should be taken to prevent the contamination of the culture.

Knop's nutrient solution, which is particularly good for the culture of algæ, consists of 4 parts of calcium nitrate, 1 part of magnesium sulphate, 1 part of potassium nitrate, 1 part of potassium phosphate. These should be dissolved in sufficient water to make a 0.2 per cent. or 5 per cent. solution of the combined salts. The potassium salts should first be dissolved, then the magnesium salt, and last the salt of calcium should be added after having been dissolved by itself. By this procedure only a small amount of insoluble calcium phosphate is formed. The zoospores of Vaucheria may be induced to form at almost any time by transferring this alga from the above solution, in which it has been growing exposed to a bright light, to pure water; or cultures in a 0.1 per cent. or 0.2 per cent. nutrient solution which have been exposed to the light need only be placed in a dark place in order to incite the production of zoospores.

A 2 per cent. to 4 per cent. solution of cane-sugar may be used as a nutrient medium for algæ. Filaments of spirogyra may be made to conjugate by transferring them from the water in which they have been growing to a solution of cane-sugar as above, which is then placed in a well-lighted place.

The formation of zoospores may be incited in œdogonium by transferring filaments of the alga from water at a low temperature (say at the temperature of the early morning) to a 2 per cent. or 3 per cent. solution of cane-sugar which is kept at a constant temperature of about 26° C.

Convenient flasks for the preservation of sterilized fluid nutrient media may be made from glass tubing as follows: A piece of glass tubing 0.2 inch in diameter, or larger, is held with its lower end in the flame of a blow-pipe, the tube being constantly revolved about its long axis to insure an even heating of the end of the tube until the end of the tube becomes soft and just begins to draw downward in the form of a large drop. By this time the mouth of the tube has become closed. Then quickly the tube is removed from the flame, and while the melted end of the tube is still held downward, air is blown in at the upper end of the tube by means of the mouth, so that the molten glass at the lower end of the tube is forced outward in the form of a rounded flask. After cooling so that it may be handled, the tube is held in the flame close to the bulb, and by constant turning the tube is heated equally on all sides until

it becomes so soft that it may be drawn out. This process is accomplished by taking the tube from the flame and pulling on it gently so that it may be drawn out quite long and narrow. The length of the stem of the bulb should be equal to the depth of the vessel from which the nutrient medium is to be drawn into the bulb. The stem may be severed from the tube by holding it in the flame of the blow-pipe at the proper distance from the bulb, where it will soon become soft enough to be pulled off from the main tube. Then the end of the capillary neck is held in the flame until a bead is formed; in this way the flask is hermetically sealed. To fill the flask with nutrient fluid the neck is sterilized near the end by passing it through a flame, and the head is broken off with sterilized forceps. The bulb is then heated in the flame of an alcohol lamp or Bunsen burner to expand the air. The end of the neck is next quickly dipped into the nutrient fluid, which is forced up the neck into the bulb as the air in this cools. When the bulb is two-thirds full, the neck is withdrawn from the fluid and hermetically sealed in a flame. In filling the bulb the greatest care must be taken to keep the stock of nutrient medium from any source of contamination, if it has once been sterilized. Chemical flasks with narrow necks serve well for a common receptacle. These should be kept stoppered with a cotton plug, and to fill the small flasks the plugs need only to be lifted slightly while the sterilized capillary neck of the small flasks is thrust past the plug into the nutrient fluid. If the nutrient fluid is freshly prepared, and has not yet been sterilized, the small flask may be filled, sealed up in the flame, and sterilized in the steam sterilizer or in a vessel of boiling water for an hour each day on three successive days. The nutrient fluid will keep indefinitely in the little flasks, and when a drop is wanted for a drop culture, it is only necessary to sterilize the end of the capillary neck in a flame, break off the bead with sterilized forceps, invert the flask, and place the palm of the hand over the bulb. The heat of the hand will expand the air over the fluid and force the latter down the neck. With a little practice just the desired amount of fluid can be forced out by the heat of the hand. The hand must not be placed on the bulb until the flask is inverted. If it is desired to make cultures within the little flasks, snip off the end of the capillary neck as before, and thrust a long platinum needle, the end of which has been in contact with the source of inoculation, down the neck into the fluid. Then withdraw the needle and hermetically seal the neck in the flame. When cultures are to be made in the flasks, these should be only one-third filled by the nutrient medium; there will then be sufficient air in the flasks for the success of the culture after the flasks have been inoculated and hermetically sealed.

Pollen grains may be made to germinate in hanging drops composed of 100 parts of well-water, 3 to 30 parts of cane-sugar, and 1.5 parts of gelatine. This should be made as needed, or it may be sterilized and kept indefinitely in the little flasks just described. The amount of cane-sugar to give the best results varies with the species of pollen, and can only be determined by experiment, but 3 parts will probably answer for most pollen-grains.

Spores of ferns may be made to germinate on pieces of flower-pot which are kept half submerged in water and are covered by a bell-jar. They should be set before a north window. They should never be exposed to the direct light of the sun, since in such a position the temperature under the bell-jar would become very great.

Orchella (Orseille).—Sections of tissues containing actinomyces may be stained to advantage by an orchella stain prepared as follows: Orchella which has been left in the open air until it is free from its ammonia is dissolved in a mixture of 20 Cc. of absolute alcohol, 5 Cc. of concentrated acetic acid, and 40 Cc. of distilled water, until the

mixture has a dark-red appearance. Sections are left in the filtered solution for one hour. They are then washed in alcohol, stained with gentian-violet, washed again in alcohol, placed for a short time in xylol, and mounted in Canada balsam. By this treatment the fungus will be double-stained red and blue.

Orseillin and Aniline Blue.—The mycelium of the Peronosporeæ may be stained blue, and the cell-walls of the plant which the fungus is parasitizing may be stained red at the same time by a combination of orseillin and aniline blue. Sections of tissues containing the parasite are bleached in Javelle water, then washed in a saturated solution of potassium hydrate in alcohol. The sections are placed for staining in acetic acid, to which have been added a few drops of an aqueous solution of orseillin BB and a drop or two of aniline blue. The solution should have a violet color. The sections may be mounted for examination in glycerine.

Osmic Acid.—The method of preparing a solution of osmic acid and of its use in Flemming's fixative is given on p. 528. The vapor of osmic acid may be used as a fixative for very small organisms. In order to accomplish this a drop of water containing the organisms need only to be inverted over a bottle containing a 2 per cent. solution of the acid. Osmic acid colors ethereal and fatty oils from brown to black, but other organic substances are also darkened by it; and as a test for oils it is not absolutely reliable. Aleurone grains in sections of Ricinus which have been freed from their oil by standing for a time in strong alcohol may be stained brown, and the crystalloid and ground substance differentiated by immersing the sections for a short time in a 1 per cent. solution of osmic acid.

Paraffin.—The directions for imbedding material in paraffin are given on p. 529. Paraffin of about 52° melting-point sections to good advantage at a temperature between 21° and 24° C., or 70° and 75° F. Good cells for hanging-drop cultures may be made by placing glass slides on the turntable and spinning rings on them by means of a camel's-hair brush dipped in melted paraffin.

Pepsin.—One part of pepsin-glycerine and 3 parts of water acidulated with 0.2 per cent. of chemically pure hydrochloric acid. When sections containing protoplasts are subjected to this reagent at blood temperature, certain structures of the protoplast which are insoluble in the reagent may be isolated from those which are soluble. In the dividing nucleus the kinoplasmic spindle-fibers persist after the chromosomes and nuclear plate have been dissolved by this reagent. By the action of digestive ferments on aleurone grains the ground substance is first dissolved and then the crystalloid more slowly, while the limiting membrane of the vacuole occupied by the aleurone grain persists. Digestive ferments are thus found to be excellent reagents for demonstrating the difference in constitution of the finer structures of the protoplast and protoplasmic cell-contents.

Phloroglucin.—This furnishes one of the most reliable tests for lignin. Sections are placed in alcohol containing a trace of phloroglucin, transferred to a drop of water on a slide, and covered with a cover-glass. A drop of hydrochloric acid is then applied to the edge of the cover-glass, and, as the acid comes in contact with the lignified membranes, these are colored a bright violet red.

Phospho-molybdic Acid.—This is used as a test for proteids. Sections are treated for an hour or two with a solution of 1 Gm. of sodium-molybdium phosphate in 90 Gm. of distilled water and 5 Gm. of concentrated nitric acid. Proteid materials then take on the appearance of yellow granules.

Picric Acid.—The structures of aleurone grains are well differentiated by fixing in a concentrated alcoholic solution of picric acid and subsequent staining with eosin.

The sections are to remain in the alcoholic fixative for several hours. They are then to be washed out in alcohol and stained for a few minutes in a solution of eosin in absolute alcohol. Then the sections are successively washed in absolute alcohol, transferred to oil of cloves, and mounted in Canada balsam. The ground substance is dark red, the crystalloid yellow, while the globoid remains colorless. The pyrenoids and chromatophores of algæ may be simultaneously fixed and stained by placing the algæ for an hour or longer in a concentrated solution of picric acid in 50 per cent. alcohol, to which has been added about 5 drops of a solution of 20 Gm. of acid fuchsin in 100 Cc. of aniline water. The aniline water is prepared by shaking up 3.5 Gm. of aniline in 96.5 Gm. of water. The algæ are then washed in alcohol, transferred to xylol, then to a thin solution of balsam in xylol, and are finally mounted in the thicker solution of Canada balsam in xylol.

Alcohol is a better solvent of picric acid than water, and accordingly it gives quicker results in washing out the acid from the fixed material than water does, but running water may be used to wash out the fixative whether the latter has been dissolved in alcohol or in water.

Picro-aniline Blue.—A double stain, which is very rapid in its action, is prepared by adding aniline blue to a saturated solution of picric acid in 50 per cent. alcohol until the solution has a blue-green color. By this treatment the unmodified cell-walls and the cell-contents are stained blue, while the lignified walls are stained by the picric acid.

Picro-nigrosin.—A solution of nigrosin in a concentrated solution of picric acid in water or 50 per cent. or 95 per cent. alcohol is a good fixative and stain for algæ and leucoplasts, and for double-staining modified and unmodified cell-walls. The solution may, in some cases, need to act for 24 hours. The strong alcoholic solution is particularly recommended for material containing chlorophyll, since this will be extracted by the strong alcohol. Nuclei and leucoplasts are stained a steel blue by the nigrosin.

Potassium Alcohol.—Used for bleaching sections. It may be prepared by mixing a concentrated aqueous solution of potassium hydrate with 90 per cent. alcohol until a sediment is formed. This is allowed to stand for 24 hours with frequent violent shaking, and then the clear liquid is poured off and is diluted for use with 2 or 3 parts of water.

Potassium Hydrate.—For general use, dissolve 5 Gm. of potassium hydrate in 95 Cc. of distilled water. This is used as a clearing agent for sections and small organisms. The process of clearing may require from several hours to several days. After clearing, the potash should be washed out in plenty of water, and then the preparation may be neutralized with acetic acid. This will tend to make the objects more opaque, and if too much is added, the objects may be cleared again by caustic potash or ammonia. A dilute solution of caustic potash, as above, may be used for the maceration of cork, while delicate tissues in general may be macerated by boiling for a few minutes in a 50 per cent. solution of potassium hydrate in water; the tissues should then be washed in water and teased out on a slide in a drop of water.

Ruthenium Red.—An aqueous solution is an excellent stain for pectic substances and for gums and slimes which have been derived from these. Ruthenium red is not soluble in alcohol, clove oil, or glycerine, and, therefore, preparations stained by it may be dehydrated and mounted in glycerine or balsam.

Safranin.—A saturated solution of safranin in alcohol should be made and this

should be diluted with an equal bulk of water, or with an equal bulk of a saturated aqueous solution of safranin. This is an excellent general stain, and gives good differentiating effects when used singly. It is one of the few stains which are particularly adapted to the staining of pectic compounds. It also gives beautiful results in staining the cell-contents of spirogyra and other algæ. The algæ, after fixing in a fixative containing chromic acid, should lie in the alcoholic solution diluted with an equal bulk of water for 12 or 24 hours. They should be transferred to 50 per cent. alcohol, to which strong alcohol is then added, drop by drop. The color will begin to be extracted in the alcohol, and when the right intensity has been reached, the material should be transferred to dilute glycerine, where it is to remain while the glycerine slowly concentrates in a place protected against dust. Then permanent mounts may be made in glycerine or glycerine-jelly. The stain given by safranin is quite permanent. See also under Double Staining, and the directions there given for the three-color method.

Salicylate of Soda.—A clearing reagent which for small objects is not inferior to chloral hydrate is furnished by dissolving crystals of salicylate of soda in an equal weight of distilled water. With tincture of iodine added this reagent will cause starch to swell, at the same time imparting a blue color to it.

Salt.—A 4 per cent. or stronger solution of common salt, or of potassium nitrate, may be used to cause plasmolysis in living cells. This process may be all the more clearly seen by adding eosin to the salt solution.

Shellac.—A thick solution of shellac in alcohol, to each ounce of which are added 20 drops of castor oil, makes an excellent sealing medium for preparations mounted in glycerine or glycerine-jelly, or in an aqueous medium.

Silver Nitrate.—A solution of silver nitrate is used to bring out more clearly the striations in bast fibers and starch-grains. Sections containing striated bast fibers are allowed to dry and are then impregnated with the silver salt. Without previous washing the sections are transferred to a 0.75 per cent. solution of common salt. They are then placed in distilled water and exposed to the light for a considerable time; thereafter they are allowed to dry and may be examined to good advantage in anise oil.

Dry starch-grains are put to soak in a 5 per cent. solution of silver nitrate. After a time they are allowed to dry superficially and are then treated with a 0.75 per cent. solution of common salt, in which they are finally exposed to the direct light of the sun to reduce the chloride of silver which has been formed within the grains. The less dense laminæ of the starch-grains will show a gray color, due to the reduced silver. See page 547 for a description of the structure of starch-grains.

Staining Intra Vitam.—Living protoplasts may accumulate certain stains from very dilute solutions without injury to themselves. Dahlia, methyl-violet, mauvein, and methylene-blue are particularly suitable for this purpose. Solutions containing 0.001 per cent. or 0.002 per cent. of any of the first three stains have given good results in staining living nuclei, while 1 part of methylene-blue in 500,000 parts of filtered rain-water is used for staining living cells containing tannin. A large amount of these very dilute solutions should be employed in order that a sufficient amount of coloring matter may be at hand for accumulation by the living cells. Living protoplasts have the power of reducing and accumulating metallic silver from solutions of certain of the salts of silver, while dead protoplasts have not this power. The simplest method of producing this reaction is to place a few filaments of spirogyra in a liter of a mixture of 1 part of silver nitrate in 100,000 parts of water with 5 Cc. of lime water. The experiment will be completed in about half an hour if the temperature

of the solution is raised about 30° C. By this process living protoplasts are colored black by the reduced silver, while dead protoplasts take on a yellowish or brownish color.

Sulphuric Acid.—By the action of sulphuric acid cellulose is changed to amyloid, which may be colored blue by a tincture of iodine. By the continued action of concentrated sulphuric acid cellulose becomes dissolved. Cutinized and lignified membranes remain undissolved in sulphuric acid. Silicious skeletons or incrustations may be freed of all organic matter by treating the objects with concentrated sulphuric acid until they turn black, and then with a 20 per cent. aqueous solution of chromic acid. The objects should be washed repeatedly in water before they are ready for examination with the microscope.

Tannin and Antimonium-potassium Tartrate.—These are used successfully as a mordant for methyl- and gentian-violet, fuchsin, and safranin when sections stained with these stains are to be mounted in glycerine. The sections before staining are placed in a 20 per cent. solution of powdered tannin in cold water. After washing well in distilled water, they are placed for 24 hours in a 2 per cent. solution of antimonium-potassium tartrate. After washing again in distilled water, they are transferred to the stain. From the stain the sections are washed quickly in distilled water and placed in strong alcohol, where the color is washed out until the desired degree of intensity is reached. They are now ready for mounting in glycerine, or, if desired, they may be placed in xylol and then mounted in balsam. If the sections are so deeply stained that they cannot be sufficiently washed out in alcohol, they should be placed for a time in a 2.5 per cent. solution of tannin.

Turpentine.—This may be used to dissolve paraffin from sections which have been cut from material imbedded in paraffin. See also under Carbolic Acid.

Venetian Turpentine.—To prepare a mounting medium from Venetian turpentine the product as it comes from the apothecary is diluted with an equal volume of strong alcohol, and after the mixture has become clear by long standing or by filtering after being well shaken, it is thickened somewhat on the water-bath. Objects may be mounted directly from strong alcohol into Venetian turpentine as above prepared. Objects which are found to shrink by this treatment may be transferred from strong alcohol to a mixture of 10 parts of the turpentine with 100 parts of alcohol. The alcohol is then to be withdrawn from this mixture by placing the latter, together with a dish of calcium chloride, under a bell-jar. In order to keep the mixture of turpentine and alcohol from mounting the sides of the vessel which contains it, the rim of the vessel should be coated over with hot paraffin. The turpentine hardens quite slowly, and in order quickly to fasten a cover-glass to the slide when the turpentine is being used for a permanent mount, a wire which has been heated in a flame should be quickly drawn around the edge of the cover-glass.

Xylol.—This is used as a solvent for paraffin, either in removing paraffin from sections or in preparing a dilute solution of paraffin to be used in the gradual infiltration of tissues with this substance. Used also as a solvent of Canada balsam.

CHAPTER X.—METHODS OF DEMONSTRATING THE CHARACTER OF CELL-WALLS AND CELL-CONTENTS.

Aconitine, $C_{33}H_{43}NO_{12}$.—To demonstrate aconitine, treat sections with a solution of potassium iodide-iodine. If aconitine is present, a carmine-red color will be produced. Treatment with a mixture of equal parts of sulphuric acid and water gives a similar color. Treatment with a solution of cane-sugar and then with the dilute sulphuric acid produces a brilliant carmine-red color.

Aleurone.—See page 549 for a description of the general nature of aleurone grains. The protein nature of aleurone is shown by the fact that it dissolves with a red color on the application of Millon's reagent, and assumes a yellowish or brownish color with tincture of iodine. The aleurone grains of ricinus are best studied from material that has been fixed in a saturated alcoholic solution of picric acid, or sections from fresh material may be fixed as above, rinsed in alcohol, stained with an alcoholic solution of eosin, cleared in oil of cloves, and mounted in Canada balsam. By this process the ground substance is stained red, the crystalloid yellow, while the globoid is usually colorless. For characteristic reactions of aleurone with other reagents, see in the last chapter under Borax-carmine, Digestive Fluids, Gold Chloride, Pepsin.

Alkaloids.—Sections which are to be tested for alkaloids should be sufficiently thick to leave one cell-layer intact. In order to make the determination of the alkaloid more certain, sections for control should be soaked for a day or so in a solvent of alkaloids prepared by dissolving 1 part of tartaric acid in 20 parts of alcohol; and then the sections should be rinsed in water for a day to wash out the acid solution. Sections which have been thus treated should be mounted under the same cover-glass with untreated sections, and the reagents for testing for alkaloids applied. It is best, on the whole, to mount the sections directly in the reagent which is to be used as a test for the alkaloid, since some alkaloids might be dissolved out if the sections are first mounted in water.

With the following reagents most alkaloids are thrown down in the form of amorphous or crystalline precipitates: Potassium iodide-iodine, potassium bismuthiodide, chlor-zinc-iodide, potassium-mercuridiodide, chloride of gold, ammonium-molybdate. The crystalline precipitates can be studied to best advantage by means of a polarizer attached to the microscope.

The vapor of iodine may often be used to good advantage in the detection of alkaloids in the following manner: A few grams of iodine are placed at the bottom of a small exsiccator, and a layer of sand about a centimeter deep is placed over the iodine to prevent its too rapid evaporation. Sections which have been treated with a solvent of alkaloids, and sections which have not been thus treated, are mounted on the same slide and placed on the upper part of the exsiccator, where they are to remain for several hours. The sections are then covered with a drop of paraffin oil, which will not dissolve the precipitate, and covered with a cover-glass for examination under a microscope, preferably with a polarizing attachment.

Allyl Sulphide, or Garlic Oil, $(C_3H_5)_2S$.—This may be demonstrated by treating portions of a species of Allium with a solution of palladous nitrate, which produces with allyl sulphide a kermes-brown precipitate, or the material may be treated with a 2 per cent. solution of silver nitrate, in which case sulphide of silver will be produced. The material may then be hardened in alcohol and sectioned.

Ammonia, NH_3.—The demonstration of ammonia in plant tissues is given in the preceding chapter under Nessler's Reagent.

Amygdalin.—This nitrogenous glucoside is particularly abundant in bitter almonds and in the bark, leaves, and flowers of *Prunus padus*. It may be extracted by boiling water, and from a mixture of alcohol and water it crystallizes out in the form of transparent orthorhombic crystals. From 80 per cent. alcohol it crystallizes in the form of pearly scales. It is split up into prussic acid, oil of bitter almonds, and sugar by an enzyme known as emulsin, which occurs within the plant along with the amygdalin.

Amylodextrine.—This substance occurs in those starch-grains which take on a reddish color with iodine, and it is formed by the action of diastase and acids from the amylose of those starch-grains which are colored blue with iodine. By the action of diastase on the starch of germinating seeds the amylose of the starch is converted first into amylodextrine, and this in turn into dextrine and isomaltose. The microchemical behavior of amylodextrine is given by Arthur Meyer as follows: Water at 70° C. dissolves crystals of amylodextrine slowly, while at 100° the crystals are dissolved at once. A solution of 10 Gm. of pure calcium nitrate in 14 Gm. of water dissolves crystals under the cover-glass very slowly. After some hours, if a solution of iodine is added, the calcium nitrate solution is colored brown, which indicates that the crystals of amylodextrine have at least been partially dissolved. A solution of 2 Gm. of purest potassium hydrate in 100 Gm. of water dissolves small crystals within 2 hours, while the solution of larger crystals requires a longer time. A solution of iodine, prepared as directed on page 621, colors the crystals dark brown. A 25 per cent. solution of hydrochloric acid dissolves large and small crystals immediately. When this solution is diluted with 4 parts of water, it takes on a brownish-red color with the iodine solution. When 1 drop of malt extract is added to 5 drops of a neutral solution of amylodextrine this becomes inverted within 10 minutes, so that it no longer is colored by the iodine solution. To prepare the malt extract treat 1 part of malt with 3 parts of water and filter the solution. The solution of crystals of amylodextrine by the malt extract requires several days. At a temperature of 40° C. saliva dissolves the amylodextrine crystals within 48 hours. To prepare the saliva mix human saliva with a drop of chloroform, filter, and preserve over a few drops of chloroform.

Amyloid.—This occurs as reserve material in the seeds of *Tropæolum majus*, *Impatiens balsamina*, *Pæonia officinalis*, and in many other plants. It is colored blue by dilute solution of iodine, but with a concentrated solution it is colored a brownish-orange. It is soluble in cuprammonia only after a day. Treated with a 30 per cent. solution of nitric acid it swells strongly, and finally dissolves. This is different from the amyloid produced by the action of acids and certain chlorides on cellulose.

Amylose.—Starch-grains which are colored blue by iodine—that is, most starch-grains—are, according to Meyer, composed of crystals of two kinds of amylose, named by Meyer α-amylose and β-amylose. The α-amylose has been isolated in crystalline form, but the β-amylose has not been isolated, and its microchemical behavior has only been determined by experiments with starch-grains. The microchemical behavior of the α-amylose is as follows, the reagents being prepared as directed under amylodextrine: Water at from 60° to 100° C. does not soon dissolve the crystals of this amylose. Treatment with the calcium nitrate solution for 30 minutes does not appear to affect the crystals. The solution of iodine does not color the crystals at first, but after a longer time it imparts a brownish color. The solution of hydrochloric acid dissolves the crystals at once, and the solution, diluted with four times its bulk of

water, is colored deep blue with the iodine reagent; but after the solution has stood for 12 hours it is colored brownish or not at all by the iodine. The solution of potassium hydrate at ordinary temperatures affects the crystals so that they are colored blue by the iodine after the solution has been neutralized with acetic acid. In boiling potassium hydrate the crystals are changed into viscid drops. If the solution is now neutralized with acetic acid and diluted with four times its bulk of water, it takes on a deep blue color with the iodine reagent.

If a drop of malt extract is added to the solution formed by boiling crystals of α-amylose with the potassium hydrate solution, and exactly neutralizing with acetic acid, it is found after 5 minutes that the solution takes on a red color, due to the formation of amylodextrine by the influence of the malt extract. Saliva and malt extract have very little effect upon α-amylose. After treatment with these reagents for 15 days at a constant temperature of 40° C., no essential change could be detected.

β-Amylose is insoluble in cold water, but at a temperature of 70° C. it forms viscid masses or minute droplets. The solutions of calcium nitrate, potassium hydrate, and hydrochloric acid have the same effect as water, excepting that the solution in hydrochloric acid is more complete than in water. The solution of β-amylose acts precisely as the solution of α-amylose. Undissolved β-amylose, however, is colored blue by the iodine solution. The swelling of starch in hot water is probably due to the β-amylose which it contains. Meyer considers α-amylose and β-amylose to be the same substance, but that the latter contains water of crystallization, while the former does not.

Anthochlorin.—A yellow coloring matter dissolved in the cell-sap of flowers, and differing from the yellow coloring matter xanthin occurring in chromoplasts in that it is not changed to a blue color by the action of concentrated sulphuric acid.

Anthocyanins.—These are coloring matters of flowers which impart red, violet, blue, blue-green, or green colors, the character of the color being dependent on the alkalinity or acidity of the cell-sap. The anthocyanins are soluble in water, alcohol and ether, and are decolorized in strong alkalies.

Anthoxanthin.—This yellow coloring matter in the chromoplasts of flowers and fruits takes on a blue color with concentrated sulphuric acid. Since the chromoplasts of flowers and fruits were first of all green, anthoxanthin is probably a derivative of chlorophyll. Anthoxanthin is also called xanthin and xanthophyll.

Arabin.—This is the gum derived from species of Acacia and known as gum arabic. Arabin is soluble in hot and cold water, and insoluble in alcohol and ether. The aqueous solution will mix with glycerine, but concentrated glycerine has little effect on the hard gum.

Asparagin, $C_2H_3NH_2.CONH_2.COOH$.—This is a nitrogenous compound of simpler constitution than that of proteids. It is formed within plants both analytically by the decomposition of proteid, and synthetically probably by the combination of ammonia with formic aldehyde. Asparagin is soluble in water and in the cell-sap, and is one of the most important nitrogenous compounds which are capable of solution and circulation within the plants. It combines with non-nitrogenous compounds to form proteids, and is apt to accumulate in those parts of plants where there is not sufficient non-nitrogenous material at hand for the formation of proteids. The accumulation of asparagin is particularly apt to occur in plants which are grown in the dark, so that carbon assimilation does not take place. Thus, Pfeffer found that when seedlings of lupin were grown in the dark, they contained a large amount of asparagin, but when they were brought to the light, the asparagin disappeared. He found that this was not due simply to the influence of the light, for when the seedlings

were exposed to the light in an atmosphere destitute of carbon dioxide, the asparagin persisted in the seedlings. For the ready demonstration of asparagin, tubers of dahlia may be employed. Rather thick sections are cut from a tuber while the razor is kept dry and transferred to a few drops of alcohol on a glass slide and covered with a cover-glass. On the evaporation of the alcohol crystals of asparagin in the form of rhombic plates are deposited on the cover-glass and slide. To determine whether the crystals are asparagin, they are treated with a few drops of a saturated solution of asparagin, which must be entirely saturated and of the same temperature as the preparation. If the crystals are asparagin, instead of being dissolved they will increase in size, while other substances than asparagin will dissolve in the saturated asparagin solution just as they would in water. It is characteristic of asparagin that if the crystals are heated to 100° C., they lose their water of crystallization and appear like bright droplets of oil. At 200° asparagin becomes decomposed and forms frothy brown droplets which are no longer soluble in water.

Atropine, $C_{17}H_{23}NO_3$.—In sections containing atropine a solution of potassium iodide-iodine produces a brown precipitate, while phosphomolybdic acid produces a yellow precipitate.

Bassorin.—Gum tragacanth, obtained from certain cells of the pith and medullary rays of several species of Astragalus. Swells strongly in water, but does not go into complete solution. Is not colored either by iodine or chloroiodide of zinc.

Berberine, $C_{20}H_{17}NO_4 + 4\frac{1}{2}H_2O$.—This occurs in the young parenchymatous tissue, and in the older xylem portions of *Berberis vulgaris*. With potassium iodide-iodine it forms a reddish-brown precipitate which, by treatment with alcoholic potassium iodide-iodine, becomes changed into tubular or hair-like forms which have a brownish or iridescent green color. Ammonium and nitric acid impart to berberine a reddish-brown color. A solution of potassium bichromate or potassium iodide in 50 per cent. sulphuric acid produces, with berberine, an intense purplish-red color. One part of nitric acid mixed with 100 parts of water added to sections containing berberine will produce clustered acicular crystals of berberine nitrate within the berberine-bearing cells.

Betulin.—This occurs in the form of fine granules in the thinner walled cork cells of birch bark. In order that it may be studied to good advantage under the microscope, the air should be pumped from sections immersed in water, and then the sections should be examined in water under the microscope. Betulin is insoluble in water, but is soluble in alcohol. It is strongly antiseptic, and protects birch bark against the attacks of lower organisms.

Betuloretic Acid, $C_{36}H_{66}O_5$.—This is secreted by the glandular hairs on the leaves of *Betula alba*. It is obtained from the thick, pale yellow secretion by successive solution in boiling alcohol, ether, and an aqueous solution of sodium carbonate. It is colored a beautiful red by concentrated sulphuric acid.

Brucine, $C_{23}H_{26}N_2O_4 + 4H_2O$.—Brucine occurs in the seeds of various species of strychnos. Ammonium vanadate in sulphuric acid gives with brucine a yellowish-red color. When sections containing brucine are treated with a mixture of nitric and hydrochloric acids, the cell-contents are colored a reddish-orange, which merges into yellow.

Caffeine, $C_8H_{10}N_4O_2 + H_2O$.—When sections containing caffeine (theine, methyl-theobromine, trimethyl-xanthin) are treated with a drop of concentrated hydrochloric acid, and then after a minute with a drop of a 3 per cent. gold chloride solution, some-

what slender, yellowish, silken crystals of a double chloride of gold and caffeine begin to be formed on the evaporation of the reagent. However, theobromine forms quite similar crystals when treated as above. Another method for the detection of caffeine is to place sections in a few drops of water and heat to boiling; then to allow the water to evaporate slowly and to treat the residue with a drop of benzol. On the evaporation of the benzol, caffeine appears in the form of fine needle-crystals.

Calcium.—When the ash of plants is treated with sulphuric acid, this unites with the calcium present to form crystals of gypsum. If calcium sulphate is already present in the ash, its characteristic crystals may be detected when an aqueous solution of the ash is allowed to dry slowly. If calcium is present in sections, it may be deposited in the form of crystals of calcium oxalate if the sections are treated with a solution of ammonium oxalate.

Calcium Carbonate, $CaCO_3$.—This rarely occurs in the crystalline form within the cells. It may, however, be found imbedded in, or incrusted on, the cell-walls. Calcium carbonate dissolves with effervescence when treated with dilute acetic acid. When treated with concentrated hydrochloric acid, it dissolves with the evolution of carbon dioxide gas. The ingrowths from the walls of certain cells of the leaves of *Ficus elastica*, known as cystoliths, are thickly incrusted with calcium carbonate, and afford excellent material for the demonstration of this salt within plant tissues.

Calcium Phosphate, $Ca_3(PO_4)_2$.—This salt of calcium occurs usually, if not always, in solution in the cell-sap. It may be deposited in the form of sphærocrystals when plant tissues containing it are kept for a long time in strong alcohol. When treated with sulphuric acid, the sphærocrystals are dissolved and crystals of calcium sulphate are formed in their stead. When sections containing calcium phosphate are heated on a slide in a drop of ammonium molybdate acidulated with nitric acid, a yellow precipitate is produced. This reaction may be hindered by the presence of certain organic compounds, such as potassium tartrate, in which case the sections should be treated with a mixture of 25 volumes of a concentrated aqueous solution of magnesium sulphate with 2 volumes of a concentrated aqueous solution of ammonium chloride and 15 volumes of water. In this case a crystalline precipitate of ammonio-magnesium phosphate is formed.

Calcium Oxalate, CaC_2O_4.—Crystals of calcium oxalate occur so commonly in plants that it is safe to assume that any crystals observed in fresh tissues are of this substance until the contrary is demonstrated. The crystals may occur singly in the cells, in which case their definite crystalline form can be made out, or in the form of agglomerated star-shaped clusters of crystals, or in bundles of parallel needle-shaped crystals, or they may occur very numerously in cells in the form of very minute crystals. The crystals are insoluble in water and acetic acid, but dissolve without effervescence in hydrochloric acid. When they are treated with sulphuric acid, crystals of calcium sulphate are formed in their place. Calcium oxalate appears to be an excretion formed by the union of salts of calcium, which have been absorbed from the soil, with oxalic acid which is formed by the plant.

Calcium Sulphate, $CaSO_4$.—Minute crystals of calcium sulphate occur in many desmids. They are insoluble in concentrated sulphuric acid. A solution of barium chloride dissolves them with the formation of barium sulphate.

Callose.—Callose occurs in sieve tubes, where it may close up the sieve pores. It also occurs commonly in cystoliths, and in the membranes of pollen-grains and various fungi. Callose is insoluble in water, alcohol, and cuprammonia, but it is readily soluble in cold sulphuric acid, calcium chloride, and concentrated chloride of zinc. It is insoluble in cold alkaline carbonates, but swells up without dissolving in

ammonium. Corallin, aniline blue, and a mixture of soluble blue and vesuvin, or of vesuvin and orseillin, are suitable stains for callose. The corallin should be dissolved in a saturated solution of sodium carbonate. After remaining in this solution for a time, the sections should be examined in glycerine. If the sections are overstained, the intensity of the stain may be reduced in a 4 per cent. solution of sodium carbonate. The aniline blue should be used in dilute aqueous solutions, in which the sections are to remain for about half an hour. Overstaining may be remedied by washing out in glycerine.

Calycin, $C_{18}H_{12}O_5$.—This occurs in the tissues of many lichens. Its presence may be demonstrated by moistening some of the powdered lichen with glacial acetic acid, and when the preparation dries, the long, doubly refractive crystals of calycin are deposited. When a section of lichen containing calycin is treated on the slide with a few drops of chloroform and a drop of sodium hydrate, that portion of the section which contains calycin assumes a color varying from brick-red to blue-red.

Cane-sugar (Sucrose), $C_{12}H_{22}O_{11}$.—This is of common occurrence in plant tissues. At 15° C. it is soluble in $\frac{1}{3}$ part of water. It is difficultly soluble in alcohol. When boiled with Fehling's solution, it does not at first precipitate cuprous oxide, but on longer boiling it becomes converted into glucose and lævulose, which are capable of reducing Fehling's solution. If rather thick sections containing cane-sugar (the sugar-beet affords good material) are placed for a short time in a concentrated solution of cupric sulphate, and then quickly rinsed in water, transferred to a solution of 1 part of potassium hydrate in 1 part of water, and heated to boiling, the cells containing the sugar take on a sky-blue color. A blue color is also produced by Fehling's solution when sections containing cane-sugar are heated in a drop of the solution on a slide until bubbles arise.

Carotin, $C_{26}H_{38}$.—Carotin occurs in the orange and red chromatophores of many flowers and fruits; it seems also to be an essential part of chlorophyll; it occurs in crystalline form in the roots of carrots, which have a yellow color in consequence. To demonstrate the presence of carotin in chloroplasts place pieces of fresh leaves in a 20 per cent. solution of potassium hydroxide in 40 per cent. alcohol, and leave them thus in a tightly closed vessel for several days. When the chlorophyll has been extracted from the leaves, they should be washed in distilled water and sections from them should be mounted in glycerine. Yellowish and red crystals will then be found in the cells which formerly contained chlorophyll. Carotin is insoluble in water and with difficulty in alcohol, but is readily soluble in petroleum ether, benzol, and benzine. When freshly dried leaves or roots of carrots are powdered and treated with one of these solvents, and the solution is allowed to dry or is treated with alcohol, carotin crystallizes out in the form of reddish or yellowish crystals. With a solution of iodine carotin is colored greenish or bluish; with concentrated sulphuric acid it is colored from violet to indigo blue.

Cellulose, $C_6H_{10}O_5$.—Cellulose is one of the most important constituents of cell-walls; the first-formed walls are nearly always of cellulose, together with certain pectic compounds. Modified cell-walls—namely, those which have become cutinized or lignified—have arisen by the chemical modification of cellulose, or by the infiltration of new material between the cellulose molecules, or by both of these processes. Cellulose is characterized by being soluble in sulphuric acid and cuprammonia; by being colored from violet to blue by sulphuric acid and iodine, chloroiodide of zinc, chloroiodide of calcium, iodine and aluminum chloride, iodine and phosphoric acid. See under these heads in the chapter on Reagents.

Chitin.—The walls of many fungi consist of chitin instead of cellulose. This

may be demonstrated by cutting the pileus of an agaracus into small pieces, which are then to be treated successively with dilute potassium hydrate, dilute sulphuric acid heated to boiling, alcohol, and finally ether. When this process is completed, a white substance remains which becomes hard and horny on drying, and which is insoluble to all reagents except concentrated acids, and in all other respects possesses the characteristics of chitin.

Chlorophyll.—Chlorophyll may be extracted from the chloroplasts by means of strong alcohol. When this extract is shaken up with benzol and a few drops of water, and allowed to stand for a short time, the benzol which rises to the top will contain two pigments, amorphous chlorophyll-green and carotin; while the lower stratum of alcohol will contain a crystallizable chlorophyll-green and xanthophyll. The amorphous and the crystallizable chlorophyll-green differ in the character of their spectra and in their solubility in different reagents. The amorphous form is soluble in alcohol, petroleum ether, carbon bisulphide, and benzine; while the crystallizable is soluble only in the alcohol.

Colchicine, $C_{22}H_{25}NO_6$.—This occurs in a few rows of cells immediately surrounding the vascular bundles of the corm of *Colchicum autumnale*. Treated with a mixture of 1 part of sulphuric acid and 3 parts of water colchicine is colored yellow, and this color is changed to a brownish-violet by the addition of a crystal of potassium nitrate. Iodine stains it brown, and potassic-mercuric iodide and hydrochloric acid produce with it a yellow precipitate.

Corydalin, $C_{18}H_{19}NO_4$.—This is an alkaloid which is found in the idioblasts of the Fumariaceæ. When corydalin is present, ammonia produces a dark gray color, picric acid a yellow, and potassium iodide-iodine a deep reddish-brown color.

Crocin (Saffron-yellow), $C_{44}H_{70}O_{28}$.—This is a glucoside occurring in the stigmas of *Crocus sativus*. When concentrated sulphuric acid is added to crocin, a deep blue color is produced which passes into violet, cherry-red, and then brown. Nitric acid also produces a blue color which passes into brown.

Curarin.—This occurs in the parenchyma and bast of several species of Strychnos. Concentrated nitric acid produces with it a blood-red, and dilute or concentrated sulphuric acid a carmine-red, color.

Curcumin, $C_{14}H_{44}O_4$.—Curcumin occurs, dissolved in an ethereal oil, in certain cells of the ground parenchyma of the rhizome of *Curcuma longa*. It crystallizes in the form of yellow needles which have a bluish tint by reflected light. Lead acetate forms a brick-red precipitate with curcumin, and sulphuric acid gives it a crimson color.

Cutin.—Cutin is a substance which is nearly related to suberin (which see), but is not identical with it. None of the acids derived from cutin is identical with any derived from suberin. However, the micro-chemical reactions of suberin and cutin are the same. They are insoluble in concentrated sulphuric acid and cuprammonia and are colored from yellow to brown with the iodine reagents. When heated with concentrated potassium hydrate, they form yellowish droplets and granular masses. When heated in nitric acid and potassium hydrate, they form droplets which melt between 30° and 40° C., and which are soluble in boiling alcohol, ether, benzol, chloroform, and dilute potassium hydrate. Both suberized and cutinized walls resist concentrated chromic acid at ordinary temperatures. Chemical analysis shows that cutin is composed of compound esters and fatty acids, and when heated to 300° in glycerine, it behaves as a fatty body. For staining cutinized walls, see under Cyanin, Alcannin, Chlorophyll Solution, Double Staining.

Cytisin, $C_{20}H_{27}N_3O$.—This alkaloid occurs in the seeds of *Cytisus laburnum*

and of other species of Cytisus. It occurs in less abundance in other parts of the plant, such as the petals and peripheral tissues of the stem. Potassium iodide-iodine produces with it a reddish-brown, granular precipitate which is soluble in sodium hyposulphite. Chloride of iron gives an orange-red color with cytisin. With phosphomolybdic acid a light yellow precipitate is produced, and picric acid when added to thin sections containing cytisin produces crystal groups of a reddish-yellow color.

Datiscin, $C_{21}H_{22}O_{12}$.—This glucoside is found in the cell-walls of the wood and bark of *Datisca cannabina*. Lime and baryta waters produce with it a yellow solution which loses its color on the addition of acetic or dilute hydrochloric acid. In the presence of datiscin, acetate of lead and chloride of zinc produce a yellow, oxides of copper a greenish, and chloride of iron a dark bluish-green, precipitate.

Dextrine, $C_{12}H_{20}O_{10}$.—This is one of the intermediate products between starch and maltose (see Amylose). It is easily soluble in water, and from its aqueous solution it may be precipitated by strong alcohol. It is not colored by iodine, and does not reduce salts of copper.

Dextrose (Glucose, Grape-sugar).—See under Glucose.

Diastase.—To demonstrate the presence of diastase in sections they are laid for a time in a dark brown solution of guaiacum in absolute alcohol. When the sections are completely infiltrated with this solution the alcohol is allowed to evaporate, and then the sections are placed in a rather dilute solution of hydrogen peroxide. By this treatment cells containing diastase are colored a beautiful blue. See also under Diastase Solution in the preceding chapter.

Dulcite, $C_6H_{14}O_6$.—Dulcite may be demonstrated in sections from one-year-old stems of *Euonymus japonicus*. The sections are placed on a slide in a few drops of alcohol, and covered with a cover-glass. After the alcohol has slowly evaporated from under the cover-glass, crystals of dulcite will be deposited in the form of long, branched prisms or needles radiating from a common center. They are distinguished from crystals of potassium nitrate by dissolving in diphenylamine and sulphuric acid without coloration, and by being insoluble in a concentrated solution of dulcite.

Elaioplasts.—These are rounded or irregularly polygonal, more or less granular bodies, consisting of a protoplasmic stroma and inclosed oil, which occur closely applied to the nucleus in the epidermal cells of many monocotyledonous and some dicotyledonous plants. In old cells the elaioplasts have the appearance of a sponge saturated with oil. The oil in the elaioplast of *Ornithogalum umbellatum* may be almost instantly dissolved by means of alcohol. These elaioplasts may be fixed and stained at the same time by treating sections containing them with a dilute solution of alcannin in 1 per cent. acetic or formic acid. The acid fixes the protoplasmic stroma, while the alcannin stains the oil a beautiful red. The fixing and staining process should be complete in 5 minutes. If desired, the sections may be double-stained by transferring them from the alcannin to a solution of iodine-green and glycerine, after which they may be mounted in glycerine-jelly. The sections may also be stained in a mixture of a dilute solution of alcannin and a solution of iodine-green in 50 per cent. alcohol and 1 per cent. acetic acid.

Emulsin.—This is a glucoside-splitting ferment which occurs in certain cells of the almond and of the bundle-sheath of the leaves of *Prunus laurocerasus*. When sections are treated with Millon's reagent, the cells containing emulsin take on an orange-red color, while the surrounding cells are colored a pale rose-red. A solution of copper sulphate and caustic potash produces a violet color in the emulsin-bearing cells.

Ethereal Oils.—Ethereal oils are distinguished from fatty oils in that they may be distilled from plants along with vapor of water, and are soluble in glacial acetic acid, and an aqueous solution of chloral hydrate. At 130° C. all ethereal oils may be driven from sections, while the fatty oils remain behind. Ethereal oils are only slightly soluble in water, but they impart their smell strongly to it. They are easily soluble in ether, chloroform, and fatty oils. The spot produced on paper by ethereal oils soon disappears. They agree with the fatty oils in being browned or blackened by osmic acid, and in being stained by alcannin and cyanin.

Eugenol, $C_6H_3 . OH . OCH_3 . C_3H_5$.—Eugenol occurs in clove and pimento oil. When sections containing either of these oils are treated with a concentrated solution of potassium hydrate, long columnar or needle-shaped crystals of potassium caryophyllate are produced. When sections of cloves are used, they often become covered by the forming crystals.

Fats and Fatty Oils.—These are insoluble in cold and hot water, and, with the exception of castor oil, hardly soluble in alcohol, but readily soluble in ether, chloroform, benzol, ethereal oils, acetone, and wood spirit. They make a spot on paper which does not disappear, as in the case of ethereal oils. Most fats and fatty oils are colored brown or black by 1 per cent. osmic acid. When a drop of fat or fatty oil is placed on a glass slide in a drop of a mixture of equal parts of concentrated potassium hydrate and ammonium, the oil becomes saponified, and may assume a form like a bunch of grapes, or it may be partly or wholly changed into clusters of soap crystals. Vapor of hydrochloric acid has been used to distinguish between ethereal and fatty oils. A large and a small glass ring, such as are used for hanging drop cultures, are cemented to a glass slide, the small one being shallower than the large one, and placed within it concentrically. Hydrochloric acid is placed into the space between the rings, and the sections to be tested are placed on a cover-glass in a drop of glycerine containing a large amount of sugar.

The cover-glass is then inverted and placed on the larger ring. After the vapor of hydrochloric acid has had time to act, any ethereal oil present in the sections will take on the form of bright yellow drops which finally disappear. Fatty oils do not form yellow drops by this treatment. A solution of alcannin colors the fats red, but several hours may be required to accomplish this. A solution of cyanin in 50 per cent. alcohol is also a good stain for fats. The sections will not need to lie in this stain longer than half an hour. If sections are overstained, they may be washed out in glycerine or a concentrated solution of potassium hydrate.

Frangulin, $C_{20}H_{20}O_{10}$.—This glucoside occurs in the cortex of species of Rhamnus. It forms yellow crystalline masses which are insoluble in water, but soluble in alkalies, which produce with it a cherry-red color. Concentrated sulphuric acid produces with frangulin an emerald-green, which changes into purple, and finally the frangulin dissolves with a dark red color. Water will precipitate it from this solution.

Fungus Cellulose.—The membranes of very few fungi give the reactions of cellulose. The membranes of most fungi are insoluble in cuprammonia, and are colored from yellow to brown by chloriodide of zinc, sulphuric acid and iodine. Neither do they react in the same manner as suberized and lignified membranes. They are, therefore, considered to be a distinct substance, which is termed fungus cellulose. See also under Chitin.

Gelatinous Sheaths.—The homogeneous gelatinous sheaths which cover the entire outside of certain algæ—notably, species of Spirogyra and Zygnema—may be demon-

strated by the use of certain stains and other substances, such as India ink, which may become deposited in the sheaths. Aqueous solutions of vesuvin, methyl-violet, and methylene-blue will stain both the cell-walls and gelatinous sheaths, but the latter with less intensity. Chloroiodide of zinc will stain the walls without affecting the sheaths. Turnbull's blue may be deposited in the gelatinous sheaths in the following manner: A small number of zygnema filaments, for instance, may be tied together with a thread and placed for about 2 minutes in a 2 per cent. solution of ferrous lactate, then quickly washed in water, and transferred to a 0.2 per cent. solution of ferricyanide of potassium. A small amount of Turnbull's blue will then be deposited in the gelatinous sheaths. This process should be repeated several times, until the deposit of Turnbull's blue is sufficiently dense to cause the sheaths to stand out quite sharply. By this method very instructive double stains may be achieved with algæ which have been growing in a dilute solution of congo-red (see under this head in the preceding chapter), which stains the cell-walls, but not the gelatinous sheaths. See also in the preceding chapter under India ink.

Globoids.—The globoids found in aleurone grains consist of a double phosphate of calcium and magnesium, which is insoluble in alcohol and dilute potassium hydrate but is soluble in dilute mineral acids and in acetic, oxalic, and tartaric acids. In an ammoniacal solution of ammonium phosphate the globoids are replaced by groups of crystals of ammonium-magnesium phosphate. Treated with ammonium oxalate, they become replaced by crystals of calcium oxalate. The globoids may be isolated to a certain extent by extracting the oil from sections of endosperm containing them by means of alcohol or alcohol and ether, and then dissolving the ground substance and crystalloid by means of 1 per cent. potassium hydrate. If crystals of calcium oxalate are present along with the globoids, they may be distinguished by means of the polarizer, since they are doubly refractive, while the globoids are not.

Glucose, $C_6H_{12}O_6$.—This occurs in sweet fruits and in the leaves and other members of plants, being one of the most common forms in which carbohydrates circulate within the plant. The warty crystals of glucose which are deposited from aqueous and alcoholic solutions at low temperatures melt at 86°, and become free from water at 110° C. At from 30° to 35° C. glucose crystallizes from concentrated solutions in water, ethyl- and methyl-alcohol in the form of hard crusts, which melt at 146° C. The presence of glucose may be easily demonstrated in the fruit of the pear, for instance, and in the leaves of balsamina, or other rather translucent leaves which have been cut from the parent plant and kept fresh under a bell-jar for several days. Pieces of the flesh of a ripe pear may be put into a test-tube with Fehling's solution and brought to a boil, when a reddish precipitate of cuprous oxide will be thrown down. This reaction is characteristic of dextrose, maltose, lactose, lævulose, and many glucosides. In this instance, however, we are dealing with dextrose. This reaction may also be carried out on the microscopic slide. Sections from the pear three or four cell-layers thick should be placed on the slide in a few drops of the solution, the cover-glass should then be put on, and the solution heated until bubbles begin to arise. The microscope will then reveal the granular precipitate of cuprous oxide within the cells. Portions of the leaf of the balsamina may be treated on the slide as directed for the sections from the pear. See under Fehling's Solution in the preceding chapter.

Glycogen, $C_6H_{10}O_5$.—This is a colorless, amorphous, highly refractive substance occurring quite commonly in the cells of fungi. It is soluble in water, but within the cells it may be stained a reddish-brown by means of iodine.

Gums.—These are amorphous, transparent substances which dissolve in water more or less completely and form a sticky solution. They may be precipitated from

their aqueous solutions by alcohol. Those gums which dissolve in water completely, such as the gum of the cherry, apricot, peach, and gum arabic, are called true gums, while those which contain cellulose and are not completely soluble in water are known as mixed gums. Gum tragacanth is an example. One of the most striking characteristics of gums which may be used in their identification is their great capacity to swell in water. To follow the process of swelling with the microscope, sections should be cut from dry material with a razor which may be wetted with alcohol, but not with water. The sections should be placed on a slide in a drop of strong alcohol, the cover-glass should be put on, and a drop of water placed on the slide so that it just touches the edge of the cover-glass. As the water mixes with the alcohol and comes in contact with the section a slow swelling of the gum will begin, which may be followed very accurately through the microscope. For directions for staining and making permanent preparations of sections containing mucilages and gums see under Boracic Acid in the preceding chapter.

Hemicelluloses.—These are reserve materials which are deposited as additions to the cell-walls in the endosperm of seeds and in wood parenchyma and wood-fibers. By means of enzymes they may be converted into gums and sugars, in which forms they may be transported to those parts where growth is taking place. The hemicellulose or reserve cellulose in the endosperm of the date seed acts like ordinary cellulose in being colored blue by chloroiodide of zinc and in dissolving in cuprammonia. The reserve cellulose in the endosperm of the seeds of *Lupinus luteus* is not dissolved in cuprammonia, and does not assume a blue color when treated with chloroiodide of zinc.

Hesperidin, $C_{21}H_{26}O_{12}$.—This glucoside occurs dissolved in the cell-sap of many plants. It may be precipitated from its solution in the cell-sap by means of alcohol. The precipitate is in the form of crystals, which are colorless or slightly yellow, and are doubly refractive, so that they may be studied to good advantage by means of the polarizer. Hesperidin is also precipitated on the drying up of the cell-sap. The crystals of hesperidin are insoluble in cold and boiling water, alcohol, ether, benzine, and dilute acids, but they are soluble in solutions of caustic potash and soda, and in ammonia, yielding a yellowish color to the solvent. Hesperidin may readily be obtained for study in the unripe fruit of the orange and in the epidermal cells of *Capsella bursa-pastoris*. Hesperidin may become deposited in the form of spærocrystals, when the tissues containing it have lain for some time in strong alcohol or glycerine, acting in this respect similarly to inulin. The constituent acicular crystals of the hesperidin sphærites can be more easily distinguished than those of inulin, and when the hesperidin sphærites are treated with a drop of α-naphtol, and then with two or three drops of concentrated sulphuric acid, they dissolve with a yellow color, while, with like treatment, inulin sphærites dissolve with a violet color.

Indican.—The glucoside indican is a substance of the consistency of syrup, and of a yellowish or brownish color. It is found in *Isatis tinctoria, Phajus grandifolius* and in other indigo-bearing plants. When tissues containing indican are exposed to the air, they may take on a blue color due to the conversion of the indican to indigotin, which may be precipitated in alcohol in the form of small, tabular, bluish crystals. To demonstrate the presence of indican, tissues containing it should be placed under a bell-jar and over a dish of absolute alcohol. After standing exposed to the vapor of alcohol for 24 hours, the tissues will be colored blue by the indigo blue which will have been forced from the indican. A piece of moistened filter-paper should be placed under the bell-jar to keep the tissues from drying.

Inulin, $C_{12}H_{20}O_{10}$.—Inulin is a carbohydrate which occurs dissolved in the cell-sap of many plants, particularly among the Compositæ. It may be deposited from its solution in the cell-sap by means of alcohol. To study the sphærocrystals of inulin, pieces of dandelion or dahlia roots should be placed in 50 per cent. alcohol for a week or more, and then thin sections should be prepared and examined in a drop of the alcohol under the microscope. The sections should not be placed in water, since the crystals of inulin are soluble in it. The sphærites will appear applied to the walls of the cells as shown in figure 302, page 549. When the alcohol is replaced by water which is then heated over a flame, the sphærites will dissolve. If sections containing inulin sphærites are treated with a 20 per cent. solution of α-naphtol, and then 2 or 3 drops of concentrated sulphuric acid are added, the sphærites will be seen to dissolve with a violet color. Inulin does not reduce Fehling's solution.

Leucin, $C_5H_{10}NH_2 . COOH$.—Leucin belongs to the amido-compounds. It has been found in the etiolated leaves of *Paspalum elegans* and *Dahlia veriabilis*, and associated with asparagin in seedlings of various Leguminosæ, particularly in those of lupinus. Leucin crystallizes in thin plates, which are lighter than water and have the appearance of mother-of-pearl. If sections containing leucin are carefully heated on a slide under a cover-glass to a temperature of 170° C., the cover-glass will become covered with minute, scale-like crystals, which are doubly refractive and may be studied to advantage by means of the polarizer. The crystals of leucin may also be obtained if sections are treated with alcohol under a cover-glass, and the alcohol is then allowed to evaporate slowly.

Leucoplasts.—For methods of fixing and staining leucoplasts, see in the last chapter under Acid Fuchsin, Gold Chloride, and Picronigrosin.

Lignified Membranes.—Lignified membranes are distinguished from cellulose membranes by their insolubility in cuprammonia and by being colored from yellow to brown by iodine or chloroiodide of zinc. One of the most reliable tests for lignified membranes will be found in the last chapter under Phloroglucin. Aniline sulphate is also a good test for lignified membranes. The sections are first mounted in a drop of a concentrated solution of aniline sulphate, and then this is replaced by a drop of concentrated sulphuric acid. By this treatment lignified membranes are stained a golden yellow. See also under Double Staining in the last chapter.

Lipochromes.—These are yellow and red pigments which are for the most part dissolved in fatty substances within the cells, and which are colored blue by sulphuric or nitric acid, and green by potassium iodide-iodine.

Magnesium.—To demonstrate the presence of magnesium within plant tissues, sections are placed on the slide in a drop of sodium phosphate or sodium-ammonium phosphate, and a little ammonium is added. In the presence of magnesium, crystals of ammonio-magnesium phosphate are then formed, which have a coffin-lid form. When the ash of tissues containing magnesium is treated as above, the crystals are apt to form in x- or *-shaped groups.

Maltose.—Maltose is a sugar which is produced from starch by the action of diastase. Maltose reduces Fehling's solution, but only about two-thirds as much as grape-sugar (dextrose, glucose).

Morphine, $C_{17}H_{19}NO_3$.—When the latex containing morphine is treated with potassium iodide-iodine, a reddish-brown precipitate is produced, with potassium-bismuth iodide a reddish-orange, and with potassio-mercuric iodide a yellowish-white precipitate, while phospho-molybdic acid produces a yellow precipitate. A solution

of 5 drops of methylal in 1 Cc. of concentrated sulphuric acid gives a violet color to latex containing morphine.

Mucilages (see also under Gums).—Mucilage contained in sections of plant tissues may be differentiated by staining with methylene-blue. The sections may be mounted on the glass slip in a drop of a solution of 0.4 Gm. of methylene-blue in 100 Cc. of equal parts of water, glycerine, and 95 per cent. alcohol. The mucilage will be seen under the microscope to be stained more deeply blue than the cell walls or other cell contents. If the sections are taken from fresh materials, the razor should be moistened with alcohol. Dry materials should be soaked in water to soften for cutting. If it is found that the mucilage dissolves too much in the water, the mucilage may be hardened and the tissues softened at the same time in the lead acetate solution described under Gums.

Myrosin.—Myrosin is an enzyme occurring in certain specialized cells in the seeds and other parts of many Cruciferæ. The cells containing myrosin are stained a deep red by Millon's reagent, while the surrounding cells may be stained a pale rose color. When sections containing myrosin are heated in a concentrated solution of hydrochloric acid which contains a drop of a 10 per cent. aqueous solution of orcin in each cubic centimeter, a violet color is produced in the cells containing the myrosin. Myrosin produces allylic mustard oil from potassium myronate, a glucoside occurring in the parenchyma cells which are associated with those containing myrosin.

Narceine, $C_{28}H_{29}NO_9$.—This is an alkaloid occurring in the latex of *Papaver somniferum*. When a yellow color follows the addition of methylal to the latex, the presence of narceïne is indicated.

Narcotine, $C_{22}H_{23}NO_7$.—Sodium selenate produces an orange-red color with the latex of *Papaver somniferum*, indicating the presence of narcotine.

Nicotine, $C_{10}H_{14}N_2$.—When sections containing nicotine are treated with potassio-mercuric chloride, a yellowish-white precipitate is produced. Phospho-molybdic acid gives, with nicotine, an abundant yellow precipitate. In the presence of nicotine mercuric chloride produces a white, and platinum chloride a yellow, precipitate, while potassium iodide-iodine causes first a carmine-red color and finally a reddish-brown precipitate, which gradually bleaches out.

Nitrates.—When nitrates are present in a solution, a drop of barium chloride added to a drop of the solution will produce a precipitate of octahedral crystals of barium nitrate. See also under Diphenylamine in the preceding chapter.

Nucleus.—The nucleus can best be demonstrated in tissues which have been fixed according to the directions given under Fixatives in the last chapter. Also under Iodine-green and Acetic Acid, and Methyl-green and Acetic Acid, are given directions for instantly fixing and staining nuclei. The three-color method of staining detailed on page 610 gives the best results for the dividing nucleus.

Oils.—Ethereal and fatty oils have already been discussed under separate heads, where the methods for distinguishing between the two will be found. See also in the preceding chapter under Alcannin, Cyanin, and Osmic Acid.

Oxalic Acid.—When calcium nitrate is added to sections containing oxalic acid, crystals of calcium oxalate are formed. With uranyl acetate crystals of uranium oxalate are formed in tissues containing oxalic acid. The crystals are rhombic, of rectangular form, and when large, appear of a yellow color, and, being doubly refractive, they may be studied to advantage with the polarizer.

Paragalactan.—This occurs as a thickening of the cell-walls in the cotyledons of *Lupinus luteus*. When it is heated with nitric acid, mucic acid is formed, and when heated with dilute sulphuric acid, galactose, $C_6H_{12}O_6$, and a pentaglucose are formed. When heated with phloroglucin and hydrochloric acid, a cherry-red color is produced. Paragalactan is not dissolved by cuprammonia, and is stained slightly or not at all by chloroiodide of zinc.

Paramylum.—Paramylum grains are flattened, cylindrical, stratified bodies occurring in the bodies of the Euglenæ and in the cysts of *Leptophrys vorax*. The paramylum grains are hardly affected by water, alcohol, ether, nitric acid, or concentrated chromic acid; and while they are hardly soluble in 5 per cent. potassium hydrate, they are easily soluble in a 6 per cent. solution. They may also be dissolved in concentrated sulphuric acid. They are not stained by iodine, chloroiodide of zinc, or by any of the organic coloring matters.

Pectic Compounds.—The pectic substances (pectin, pectose, and pectic acids) are widely distributed in the membranes of plants. Pectose occurs associated with cellulose in the membranes of embryonic tissues, where it is distributed throughout the entire thickness of the membrane. Pectose also occurs in most lignified, suberized, and cutinized membranes. The middle portion of cell-walls—the so-called middle lamella—consists, for the most part, of calcium pectate. When thin sections of plant tissues are treated for several hours with a mixture of 1 part of hydrochloric acid and 4 parts of alcohol, the calcium pectate becomes changed, so that pectic acid is liberated and calcium chloride is formed. The pectic acid is insoluble in water, but is soluble in a 10 per cent. solution of ammonia, so that after rinsing the sections in water and treating with the ammonia solution, the cells may be separated from each other by a slight pressure on the cover-glass. When the sections are placed for a considerable time in cold alkaline solutions, a double pectate is formed which swells in cold water and finally dissolves in it. After the calcium pectate of the middle lamella has been removed, the pectose which permeates the cell-wall still remains, but by treatment with cuprammonia it may be removed from sections which have already been acted on by dilute hydrochloric acid. The pectic substances may be stained only in neutral or slightly acid solutions. For this reason it is a good plan to place sections for a short time in a 3 per cent. solution of acetic acid, and then to wash them in water before transferring them to the staining solutions. Safranin, methylene-blue, bleu de nuit, and ruthenium-red are excellent stains for pectic substances. Safranin stains the protoplasts and the lignified, suberized, and cutinized cell-membranes a cherry-red, while the pectic compounds are stained orange-yellow. Methylene-blue and bleu de nuit stain the protoplasts and the lignified membranes blue, and the pectic substances a violet color. See also in the last chapter under Ruthenium-red.

Pezizin.—Pezizin is an orange-red coloring matter which occurs in solution within the paraphyses of *Peziza aurania* and *P. convexula*. It is soluble in alcohol and ether, and is not altered by alkalies and organic acids. It dissolves without color in hydrochloric acid and is colored bright green by nitric acid.

Phloridzin, $C_{21}H_{24}O_{10}$.—A glucoside occurring in the leaves and in the cortex of the roots and stems of the Pomaceæ. When tissues of *Pirus malus* containing phloridzin are treated with ferric chloride, a dark brown solution is formed, while treatment with ferrous sulphate causes a yellowish-brown precipitate. The tissues of the pear, cherry, and plum are apt to contain large amounts of tannins which produce a green color with salts of iron, and so mask the phloridzin reaction.

Phloroglucin, $C_6H_3(OH)_3$.—This occurs in solution in the cell-sap. To demonstrate its presence treat previously dried sections with a solution prepared by dissolving

0.005 Gm. of vanillin in 0.5 Gm. of alcohol, and adding 0.5 Gm. of water and 3 Gm. of concentrated hydrochloric acid. When phloroglucin is present, this solution produces a light red color.

Phosphoric Acid, H_3PO_4.—This can be best demonstrated in the ash. The ash is dissolved in hydrochloric acid and the solution is evaporated to dryness; then the residue is treated with ammonium molybdate, which, if phosphoric acid is present, produces a precipitate of ammonium phospho-molybdate, the crystals of which have a greenish-yellow color under the microscope. If the presence of phosphoric acid is to be sought for in fresh tissues, sections should be heated in a drop of ammonium molybdate on the glass slide. This method also produces a precipitate of crystals of ammonium phospho-molybdate in the presence of phosphoric acid. If ammonium tartrate is present in the tissues, ammonium molybdate does not serve so well as a test for phosphoric acid. In such a case a solution should be used, consisting of 25 volumes of a concentrated aqueous solution of magnesium sulphate, 2 volumes of a concentrated aqueous solution of ammonium chloride, and 15 volumes of water. With phosphoric acid this solution produces a precipitate of ammonio-magnesium phosphate the crystals of which are frequently formed in x- and *-shaped clusters.

Piperine, $C_{17}H_{19}NO_3$.—Piperine is an alkaloid occurring in the fruit of the Piperaceæ. Very thin sections may be rubbed out somewhat under a cover-glass to press out the ethereal oil, which will then evaporate and leave the piperine to crystallize in the form of minute short needles. A section becomes of a deep red color when treated with concentrated sulphuric acid, while with nitric acid an orange color is produced. When sections are moistened with sodium molybdate, and then treated with concentrated sulphuric acid, they take on a blue color. Piperine is easily soluble in acetic acid.

Proteids (Albuminoid Substances).—Proteids are stained from yellow to brown by a dark solution of potassium iodide-iodine. The dilute solution of iodine recommended for starch should not be used, for proteids are stained less readily than starch. Millon's reagent (see under this head in the preceding chapter) colors proteids a brick-red color. If the solution is old and has lost its efficiency, a few drops of a solution of potassium nitrate will probably restore it. Concentrated nitric acid colors proteids yellow, and the addition of ammonium produces a still deeper yellow. When sections lie for an hour or two in a solution of 1 Gm. of sodium phospho-molybdate in 90 Gm. of distilled water and 5 Gm. of nitric acid, which has been filtered after standing for several days, the proteid substances appear in the form of yellowish granules. A concentrated solution of nickel sulphate colors proteid granules yellow or blue. When rather thin sections are placed in a concentrated solution of copper sulphate for about half an hour, and then are placed in water for about an hour, and then are transferred to a concentrated solution of potassium hydrate, proteids are colored red or violet, which becomes deeper when the solution in which the sections are lying is heated somewhat. The pepsin-glycerine and pancreatin-glycerine ferments prepared by Dr. G. Grübler in Leipzig are solvents of proteids. Sections are treated for an hour at a temperature of 40° C. with a mixture of 1 part of pepsin-glycerine and 3 parts of water, to which is added 0.2 per cent. of chemically pure hydrochloric acid. Pancreatin-glycerine is employed in the same manner as the pepsin-glycerine.

Protein Crystalloids.—Under Aleurone in the preceding chapter are given methods of differentiating crystalloids in aleurone grains. Protein crystalloids also occur in the cytoplasm, nucleus, and chromatophores, and in all of these cases the crystalloids have essentially the same nature, but they may vary considerably in form. For staining crystalloids, see in the preceding chapter under Acid Fuchsin.

Protoplasm.—The protoplasm of the cell can be studied to advantage by means of the microscope only after being killed and fixed by such reagents as those formulated under Fixatives in the preceding chapter. The different constituents of the protoplasm can then be differentiated by means of stains or by means of digestive ferments, such as pepsin and pancreatin. Iron hæmatoxylin, or a combination of fuchsin and iodine green, or of safranin, gentian violet, and orange G, as recommended under Double Staining in the preceding chapter, are specially to be recommended for differentiating the different parts of the protoplasm. For staining the leucoplasts and chromatophores in general, see under Acid Fuchsin, page 615.

Protoplasmic Connections.—The protoplasmic connections between the plates of sieve tubes may be strongly stained by acid fuchsin and aniline water (see page 615). More delicate protoplasmic connections require the use of a swelling agent for their demonstration. Sections of fresh material may be fixed with a solution of 0.05 Gm. of iodine and 0.2 Gm. potassium iodide in 15 Gm. of water, and then the iodine should be replaced by chloroiodide of zinc, which should be allowed to act for about 12 hours. At the end of this time the membranes traversed by the protoplasmic connections will be swollen to greater or less extent, so that the chloroiodide of zinc may be washed out in water and the sections stained by acid fuchsin and aniline water, as already suggested. Sulphuric acid may be used instead of the chloroiodide of zinc as the swelling agent. For demonstration purposes sections through the endosperm of the Gramineæ, or tangential sections through the green bark of *Rhamnus frangula*, may be used. Sections are placed on a cover-glass in a drop of sulphuric acid. After a few seconds the acid is washed away by immersing the cover-glass and moving the sections about in a dish filled with water. The sections remain in the water for only a short time, and are then to be stained in an aqueous solution of aniline blue, washed in water, and mounted for examination in dilute glycerine. Or the sections may be stained in a saturated solution of picric acid in 50 per cent. alcohol, to which aniline blue is added until the solution has a blue-green color.

Pyrenoids.—The pyrenoids may be simultaneously fixed and stained by placing the material in a concentrated solution of picric acid in 55 per cent. alcohol, to a watch-glass of which is added about 5 drops of the acid fuchsin and aniline water solution described on page 615. The material should remain for about 2 hours in a watch-glass of this solution. It should then be washed for a quarter of an hour in alcohol and mounted for examination in dilute glycerine. If permanent mounts are desired, the material should be placed in a watch-glass of dilute glycerine, which should then be allowed to concentrate in a place free from dust. The material should finally be mounted in glycerine-jelly. The material may be mounted in Canada balsam by transferring it from the alcohol in which it was washed to successively stronger solutions of balsam in xylol until the ordinary solution used for mounting is reached.

See under Dahlia in the previous chapter for other methods of treating pyrenoids.

Reserve Cellulose.—Those hemicellulose thickenings of cell-walls in seeds, etc., which are essentially reserve food materials, and are made soluble by diastatic ferments and employed as food material in the germination of seeds, are known as reserve cellulose. Sections taken from a sprouted date seed and treated with potassium hydrate and stained with alizarine show the inner layers of the cell-walls which have been acted on by the diastase unstained, while the outer layers which have not yet been affected by the diastase are stained an intense violet. If Congo-red is used instead of the alizarine, the intact layers are scarcely stained, while the layers which have

come under the influence of the diastase are stained a dark red. See under Hemicellulose.

Resin.—When sections containing resin are treated for some time with a tincture of alcannin, the resin assumes a red color. When sections from tissues which have lain for about a week in a concentrated aqueous solution of copper acetate are examined under the microscope, the resin will be seen to be colored an emerald-green.

Ruberythric Acid, $C_{26}H_{28}O_{14}$.—This occurs in the roots of *Rubia tinctorium*, and is the chief constituent of the madder dye obtained from the roots of this plant. It gives a yellow color to the cell-sap of the young roots; the cell-walls of old roots, however, have absorbed it and are colored by it. It is colored a purple-red by potassium hydrate, and an orange color by acids. In dry roots it takes on the form of red flakes, and in the injured cells of fresh material it assumes the same form. It may be extracted by alcohol from its yellow solution in uninjured tissues, but in the red flake form it is not dissolved by alcohol.

Rutin, $C_{42}H_{50}O_{25}$.—This glucoside is widely distributed in plants. It crystallizes from an aqueous solution in the form of minute light yellow crystals. The yellow color of straw is, in part, due to it. When treated with ammonia or lime-water, rutin forms a deep yellow solution, which turns to brown on exposure to the air.

Salicin, $C_{13}H_{18}O_7$.—Salicin is a glucoside which occurs in particular abundance in the cortex of many poplars and willows. It may be dissolved by water, but more readily by boiling water, by aqueous solutions of alkalies, and by acetic acid. It is insoluble in ether. It crystallizes in the form of needles, scales, or thin plates. It is colored by concentrated sulphuric acid, and, on the addition of a little water, a red powder is thrown down in the sulphuric acid solution.

Santalin.—Santalin is the coloring matter of the red sandal-wood, *Pterocarpus santalinus*. Santalin is insoluble in water, but is soluble in ether with a yellow color and with 80 per cent. alcohol it gives a blood-red solution. Stronger alcohols give the same result. It is also soluble in acetic acid and in aqueous alkaline solutions.

Saponin, $C_{19}H_{30}O_{10}$.—This glucoside occurs in solution in the cell-sap. When treated with a mixture of equal parts of alcohol and sulphuric acid, a yellow color is produced which soon changes to red, and later to violet. If it is then treated with a concentrated solution of chloride of iron, a brown or bluish-brown precipitate is formed, the intensity of the bluish color increasing with the amount of saponin present.

Seminose.—Seminose is one of the products resulting from the hydrolysis of hemicellulose by sulphuric acid. It is dextrorotary, reduces Fehling's solution, and is fermentable.

Silica, SiO_2.—Silica occurs in the skeletons of diatoms, and as incrustations over the epidermis of the Equisetaceæ and Gramineæ. It also sometimes occurs in masses in the interior cells. It may be isolated from the organic matter with which it is associated by burning over a flame bits of epidermis incrusted by it, or diatoms, which are placed in a drop of concentrated sulphuric acid on a piece of platinum foil. By this treatment the organic matter will be destroyed, and the silica will remain behind as a pure white ash. The silica may also be obtained pure by placing bits of tissues incrusted by it in a drop of concentrated sulphuric acid, and then after a time adding 20 per cent. chromic acid, and following this with additions of still stronger chromic acid until a considerable strength has been reached, and, finally, washing in water and alcohol. Silica is distinguished by being insoluble in all the acids excepting hydrofluoric acid. Silicious skeletons may be removed from diatoms by placing the latter in hydrofluoric acid which is contained in a platinum vessel. The vessel should

be kept on a water-bath, and the diatoms should remain in the acid for 24 hours. At the end of this time the acid should be thoroughly washed out from the diatoms. On examination with the microscope, the diatoms will then be found to have lost their silicious skeletons. In some instances a thin exterior membrane which is stained brown by iodine is to be observed; but in other instances this membrane has been a too insignificant part of the skeleton to retain its identity after the removal of the silica.

Sinapine, $C_{16}H_{32}NO_5$.—This is an alkaloid occurring in the seeds of the white mustard. When sections of these seeds are placed in a concentrated solution of potassium hydrate, they assume a yellow color, which changes to orange on warming. This reaction loses some of its value, however, from the fact that a glucoside called sinalbine also occurs in the seeds of the white mustard and turns yellow on the application of potassium hydrate.

Solanin, $C_{42}H_{75}NO_{15}$.—This glucoside occurs in the tissues of *Solanum tuberosum*. To demonstrate its presence, sections should be placed in a mixture of 1 part of ammonium vanadate and 1000 parts of a mixture of 98 parts of sulphuric acid with 36 parts of water. This produces with solanin a yellow color, which changes successively into orange, purple-red, brown, red-orange, carmine-red, raspberry-red, and blue-violet. The color then passes into a grayish-blue and disappears. With concentrated sulphuric acid solanin assumes a yellow color, which changes to red, and then violet, and then passes into gray and disappears.

Spergulin, $C_5H_7O_2$.—This occurs in the seed coats of species of Spergula. It is soluble in alcohol with a blue fluorescence, in ether, and in concentrated sulphuric acid with a deep blue color. It is insoluble in chloroform, benzine, and in the fatty and ethereal oils. When caustic potash is added to an alcoholic solution of spergulin, an emerald-green fluorescence is produced.

Starch, $C_6H_{10}O_5$.—A solution of potassium iodide stains starch from pale violet to purple, depending on the strength of the iodine solution. Chloroiodide of zinc stains starch-grains purple, and at the same time swells them. A solution of chloral hydrate and iodine dissolves the protoplasmic cell-contents and stains included starch-grains purple. This reagent is particularly adapted to demonstrate the presence of starch in chloroplasts or amyloplasts. The bleaching effect of the chloral hydrate is so great that starch may be demonstrated in whole leaves by the chloral hydrate and iodine reagent. For the further treatment of starch with reagents, see in the preceding chapter under Eau de Javelle, Calcium Nitrate, Diastase, Methyl-violet, Silver Nitrate. For the structure of starch-grains, see page 547.

Strychnine, $C_{21}H_{22}N_2O_2$.—When sections containing strychnine are treated with a solution of 1 Gm. of ammonium vanadate in 100 Cc. of sulphuric acid, they quickly take on a violet-red color, which after a time changes to brown. If sections of the seeds of *Strychnos nux-vomica* are treated with sulphuric acid containing an excess of ceric sulphate, the walls of the cells are colored a bluish-violet. The sections must have been previously treated with petroleum ether and absolute alcohol to remove the fatty oils, grape-sugar, and brucine. The reagent should be applied immediately before the observation is to be made. If sections are treated with concentrated sulphuric acid, and crystals of potassium bichromate are then added, a violet color is produced.

Suberin and Suberized Walls.—Suberized walls are stained green when treated for about an hour in the dark by a freshly-prepared strong solution of chlorophyll. A cold concentrated solution of potassium hydrate colors suberized walls yellow. When the potassium hydrate is heated yellow drops and granular masses are formed.

When suberized walls are heated in a solution of potassium chlorate in nitric acid, they become changed into droplets which melt between 30° and 40° C., and which are soluble in hot chloroform, alcohol, ether, benzol, or dilute potassium hydrate. At ordinary temperatures concentrated chromic acid solutions have little effect on suberized walls. A solution of potassium iodide-iodine and chloriodide of zinc colors suberized membranes from yellow to brown. After long treatment with a dilute solution of potassium hydrate, suberized membranes may be stained violet with chloro-iodide of zinc. Alcannin stains suberized walls red. Under the polariscope suberized walls are seen to be doubly refractive. They lose this property on heating and regain it on cooling. It may be deduced from this that the constituents of the walls are in part, at least, in crystals which are melted by heat, but reappear on cooling. See under Methyl-blue and Double Staining.

Syringin.—Syringin is a glucoside occurring in the cortex, and to a certain extent in the xylem and medullary rays of *Syringa vulgaris*. It is especially abundant in early spring. Sections containing syringin, when treated with concentrated sulphuric acid, acquire a dark blue color, which changes to violet. Nitric acid dissolves syringin with a blood-red color. Syringin crystallizes from aqueous solutions in the form of colorless, needle-like crystals which are grouped in the form of a star. The crystals are dissolved with difficulty in cold water, but readily in boiling water or in alcohol.

Tannins.—Various substances occurring in plants having an astringent taste, and turning blue or green with salts of iron, are termed tannins or tannic acid. Oak-galls furnish excellent material to illustrate the demonstration of tannin. When sections are treated with an aqueous solution of ferric chloride, they take on a deep blue color, due to the presence of tannin. Aqueous solutions of ferrous sulphate give the same result. If the reaction is watched under the microscope, it is noticed that at first a deep blue precipitate is formed, which soon dissolves and imparts its color to the surrounding fluid. When sections are placed in a 10 per cent. aqueous solution of potassium bichromate, a flocculent reddish-brown precipitate is formed in the tannin-bearing cells. When sections are placed in a concentrated solution of ammonium molybdate in concentrated ammonium chloride, the same character of precipitate is produced as when potassium bichromate is used. Lead acetate produces a white precipitate with tannins. The following method may be employed: Sections are placed in a 7 per cent. solution of copper acetate for about a week or longer, and are then placed on a slide in a drop of a 0.5 per cent. solution of ferrous sulphate. After a few minutes, and before the cell-walls begin to turn brown, the sections are washed in water and transferred to a watch-glass of alcohol to drive out air-bubbles and extract chlorophyll, if any is present. The sections are then mounted in glycerine for examination under the microscope. By this treatment an insoluble brown precipitate is produced in the presence of tannins. The sections may be transferred from the glycerine to glycerine-jelly if permanent mounts are desired. If the sections are taken from the alcohol in which they were placed to remove the chlorophyll, etc., and placed in a solution of iron acetate, a blue or a green color will be produced, according to the kind of tannin present. If it is desired to fix the cell-contents while testing for tannins, the sections should be placed in a concentrated alcoholic solution of iron acetate instead of in the aqueous solution, as above. When living tissues are placed in a solution of 1 part of methylene-blue in 500 parts of distilled water, those cells which contain tannins take on a blue color, and later a deep blue precipitate is formed in these cells. Cells containing phloroglucin act in the same way to this reagent as those containing tannins.

Theobromine, Dimethyl-xanthin, $C_7H_8N_4O_2$.—This alkaloid occurs in the cocoa-bean. Its presence may be demonstrated by the use of hydrochloric acid and chloride of gold, as directed under Caffeine. The reactions for caffeine and theobromine are sometimes difficult to distinguish. When sections containing theobromine are heated in distilled water on the slide to the boiling-point, and the sections are allowed to dry slowly, and a drop of benzol is added to the residue, crystals of theobromine appear in the form of a fine powder on the evaporation of the benzol; whereas, when sections containing caffeine are treated in like manner, the crystals containing caffeine take on the form of needles.

Tyrosin, $C_6H_4OH . CH_2 . CHNH_2 . COOH$.—Tyrosin may be demonstrated in abundance in the tubers of the dahlia. When sections are mounted under a cover-glass in glycerine for several days, needle-shaped crystals of tyrosin are deposited in radiating groups. In an abundance of glycerine the crystals are not deposited, for the reason that the tyrosin becomes too much diffused through the glycerine. The crystals appear brownish by transmitted, and white by reflected light. When a portion of a dahlia tuber is placed in a dish of about the same size as itself, and covered for about two-thirds of its length with alcohol, an abundance of tyrosin crystals will collect at the exposed cut surface. The crystals of tyrosin are colored a deep red by means of Millon's reagent, and when nitric acid is poured over them, and then evaporated, a yellow residue is left.

Vanillin, $C_6H_3 . OH . OCH_3 . CHO$.—Vanillin occurs abundantly in solution in the pods of vanilla, or in the dry pods it occurs in an amorphous condition. It is often found in a crystalline condition on the surface of dried pods. It is soluble in alcohol and ether, and to a certain extent in hot water, but it is soluble with difficulty in cold water. When sections containing vanillin are wetted with a 4 per cent. solution of orcin, and then treated with concentrated sulphuric acid, they take on a deep carmine-red color; and when they are treated in like manner with a solution of phloroglucin in place of the orcin, a brick-red color is produced. It seems probable that vanillin is always present in lignified walls, judging from the colors which these assume with certain aromatic compounds.

Veratrine, $C_{37}H_{53}NO_{11}$.—Veratrine occurs in the tissues of *Veratrum album*. When sections are placed in a mixture of 1 drop of concentrated sulphuric acid and 2 drops of water on a glass slide, and examined under a microscope, it is to be seen that the walls or cell-contents of the cells containing veratrine assume a yellow color, which soon changes to an orange-red, and finally to a dusky violet.

Wax.—Wax frequently occurs in plants as a crust-like, or granular, or rod-like layer over the cuticle. It consists of fats and free fatty acids, together with other substances. Wax is insoluble in water, but it will melt and form droplets in water at 100° C. It is hardly soluble in cold alcohol, but will quickly dissolve in boiling alcohol. When sections containing wax are heated in a solution of alcannin in 50 per cent. alcohol, the wax runs together in droplets, which become stained red by the alcannin. Wax is not wetted by water, and sections are best mounted for study in cold alcohol, which will dissolve the wax but little, if at all.

Wound Gum.—The wounded surfaces of deciduous trees become protected by the formation of wound gum from starch contained in the live cells. Sections taken through the wounded surfaces of such plants several days after the wound has been inflicted show brownish granules of wound gum in the medullary rays, tracheal tubes, and wood-cells. The wound gum may be found lying free in the cytoplasm or sur-

rounding starch-grains which have contributed to the formation of the gum. Wound gum is not soluble in warm water, but may be dissolved in hot nitric acid or in eau de Javelle after several hours. It is not soluble in sulphuric-acid, potassium hydrate, alcohol, or ether, but it may be dissolved in alcohol after treatment for a few minutes with a solution of potassium chlorate in dilute hydrochloric acid. It may be stained with a solution of fuchsin, iodine green, safranin, or methyl-green. It is stained red by phloroglucin and hydrochloric acid.

Xanthin, $C_5H_4N_4O_2$.—Xanthin occurs in an amorphous condition or in the form of granules in yellow chromoplasts. It differs from carotin in being more soluble in alcohol, and in being deposited in amorphous and resin-like masses on the evaporation of its solvent. It is insoluble in water, and but little soluble in ether and benzine. It becomes green and then blue when treated with sulphuric acid, and with potassium iodide-iodine it is colored green.

CHAPTER XI.—THE MICROSCOPICAL EXAMINATION AND IDENTIFICATION OF DRUG POWDERS.

Effects of Pulverization upon Identification.—It is quite possible in many cases to identify the official drugs even in powdered form after the gross characteristics have disappeared through the process of pulverization. This has been made possible by the efforts of those investigators who have studied the inner morphology of drug tissues and given us methods of recognizing the various forms of these as well as the forms of cells, etc., though they have been modified in the process of drying, or curing, necessary for the preparation of the crude drug. The identification of drug powders can be accomplished only by the aid of the compound microscope. Such an examination is frequently desirable or even necessary in order to determine the purity of the material—whether it be true to name.

Formerly it was considered sufficient for identification of vegetable drugs to describe gross characteristics only, such as color, odor, taste, and such other characters as might be brought out by the simple microscope, magnifying, say, ten to fifteen diameters; but this method has become inadequate because of the new factor in drug supplies—the drug miller. He supplies these in powdered form, and the process of pulverization the druggist is glad enough to transfer to those who have laboratories especially equipped for that purpose. But it is easy to see that adulteration is made easier and its detection more difficult, hence it is necessary that students in pharmacy be made familiar with methods of microscopical analysis of drug powders.

Aids to the Study of Powders.—Most valuable aids to the study of

drug powders are the illustrated works recently published as follows: "Powdered Vegetable Drugs," by Albert Schneider, M.D., Ph.D.; "A Course in Botany and Pharmacognosy," by Henry Kreamer, Ph.D., Ph.B.; "A Microscopical Examination of Foods and Drugs," by Henry George Greenish; "Anatomical Atlas of Vegetable Powders," by Henry G. Greenish; "Pharmacognosy," by Smith Ely Jelliffe, M.D. Valuable illustrated articles have also appeared in "Merck's Report," by Burt E. Nelson, on "Microscopical Examination of Powdered Drugs." Comparatively recently there has been completed the "Anatomischer Atlas der Pharmakognosie und Nahrungsmittelkunde von Dr. A. Tschirch und Dr. O. Oesterle."

As before intimated, the practical value of these publications lies in the fact that the diagrammatic illustrations they contain serve as a guide to recognition and as a means of verification, but a sample of the drug itself, as a check or guide, answers a better purpose after the principles of microscopical examination have been mastered.

An examination of a drug powder should never be considered complete, until the sample has been compared with authentic specimens of the same drug or drugs of the same degree of fineness.

Pulverization-Powdering.—It is taken for granted that the student is familiar with the different methods of reducing vegetable drugs to powder. The various mills and appliances for the process are well illustrated in all the works on pharmacy. He has learned that the degree of fineness of a powder has much to do with the process of extraction in making the various preparations by percolation, maceration, etc. These degrees of fineness of powder are represented by certain numbers. A No. 80 powder, for example, is one that will pass through a sieve having 80 meshes to the inch. Sieves having a greater or less number of meshes to the inch, or to the centimeter, determine, therefore, the character of the powder (see Preliminary Notices in the U. S. P. on "Fineness of Powders"). A powder passing through a No. 80 sieve—"No. 80 powder"—will be found on microscopical examination to have most of the cells and cell groups recognizable. It is true, however, that a few drugs with unusually large cells, such as those grown in moist or marshy soil, will have such large cells as would be ruptured if pulverized so finely as a No. 80 or No. 100 powder—that is, a powder passing through a No. 80 or No. 100 sieve. Such drugs as these must not, therefore, be so finely pulverized for microscopical examination.

The less resisting tissues, such as parenchyma, in which is contained the starch granules, are readily reduced to powder (*e. g.*, external portion, or bark, of ipecac root), while the fibrous and more tenacious parts containing both tracheids and vessels are quite difficult to pulverize (*e. g.*, internal, woody column, of ipecac root). Accordingly the first-mentioned

powder resulting from the softer parenchymatous tissues would pass a fine sieve first and leave behind in the sieve the tenacious and wiry fibrous portion, which is very difficult to reduce to a powder form by the ordinary means; yet it is quite possible to do this, in small quantities at least, by the pestle and mortar.

Identification by Color.—Drug powders have colors which are very liable to vary. Dr. Schneider * very clearly refers to this as follows:

Exposure to light deadens the color quite rapidly, the tendency being towards grayish shades and tints. Exposure to moisture and the presence of vegetable parasites, also, greatly modifies the color, increasing fineness producing tint effects. In some instances the quality of the color is even changed; for instance, powdered licorice of medium fineness is yellow, while the fine powder is much lighter, with a decided lemon color. Roasting produces dark to nearly black colorations. Powders made from plant parts rich in oil and fat, as cloves, almonds, larkspur, stavesacre, etc., darken rapidly, and become rancid, due to the decomposition of the fats into fatty acids and glycerine. The ageing of powders, even though they are kept from light, changes them in color from deep and bright to fainter and duller tints.

The above author groups the powdered vegetable drugs according to the following colors:

I. Very light. Mostly seeds and roots.
  1. White, as starches and cereal flour.
  2. Very light, tinged with yellow, red, or some dark substance; as althæa, orris root, colocynth, etc.

II. Yellow. Mostly roots and rhizomes. A few flowers and barks.
  1. Pale yellow and straw yellow.
  2. Orange yellow and lemon.
  3. Brownish-yellow and yellowish-brown.

III. Green. Mostly leaves and herbs.
  1. Grayish-green.
  2. Brownish-green.

IV. Gray. Mostly roots.
  1. Ash gray.
  2. Brownish-gray and dark gray.

V. Brown. Mostly barks.
  1. Reddish-brown.
  2. Dark brown.

VI. Very dark. A few barks, as juglans. Roasted drugs.
  1. Very dark, tinged with red and yellow.
  2. Black, as charcoal.

* "Powdered Vegetable Drugs," Albert Schneider, p. 55.

Identification by Odor.—The odors from drugs are exceedingly difficult to describe, largely because we have no odor standards at command for comparing them qualitatively or quantitatively. We can understand such terms as aromatic, pungent, fragrant, agreeable, disagreeable, etc. These terms serve in a measure to indicate odor qualities.

The student is recommended to acquaint himself with such aromatic odors as cinnamon, cloves, nutmeg; with the mint family odors, such as peppermint, spearmint, pennyroyal, etc. He should acquaint himself with such odors as are furnished by the odorous fruits, of the Umbelliferæ, such as caraway, fennel, etc.; with camphoraceous odors, as eucalyptus, rosemary, and camphor; with pronounced and characteristic odors of wintergreen, sassafras, etc.; with the delicate and fragrant odors derived from the lemon, orange, orange flowers, etc. He should not omit the study of the disagreeable odors, as we find in conium, valerian, stramonium, garlic, civet, castor fiber, etc. All such odors serve as a means of comparison.

It will be seen that in order to describe an odor it becomes necessary to have some prominent characteristic odor with which to compare. The Pharmacopœia states that conium has a mouse-like odor; sumbul, a musk-like odor; lactucarium, a heavy odor; senna is described as having a tea-like odor, etc. Tarry substances that have a creasote or smoky odor are said to have an "empyreumatic odor."

Identification by Taste.—What has been said of the odor of drugs applies also to their taste. Taste is not a very distinctive property. There are some drugs that have a distinctive taste, such as gentian root, which has a *simple bitter taste;* senega, an *acrid taste;* ginger, a *pungent;* geranium, *astringent;* elm bark, *mucilaginous*, etc. Many drugs have what may be termed a mixed taste. Hence we find in descriptions such terms as: *bitter-astringent* applied to cinchona; *bitter-pungent* applied to orris root; *pungent-astringent* applied to cotton-root bark; *bitter-sweet,* applied to dulcamara; *sweetish-bitter-pungent*, applied to spigelia, etc. Many drugs are tasteless, such as lycopodium, kamala, physostigma, etc.

It is plain to be seen from the foregoing that the taste, as well as the color and odor of powders, is not distinctive enough to identify them with certainty; still, these physical properties serve in many cases as a valuable aid in their identification.

Identification of Adulterants.—As stated above, adulteration of drugs is made easier and the detection of these more difficult when the drug is reduced to powder. Great skill is here required in the identification of adulterants. It is necessary to have a knowledge of the microscopical elements of the drug itself, and also necessary to be familiar with the powdered materials employed in the art of adulteration. Not infrequently

do we find foreign starches which do not belong to the powders under examination, and even sawdust, coffee-grounds, powdered cocoanut shells, etc., lend themselves as adulterants. Sometimes inorganic substances, such as clay and other earthy materials, sand, etc., are employed. One of the most difficult adulterants to detect and identify is the exhausted powders (the dregs left from drugs extracted by percolation). These are first dried and repowdered and mixed in various proportions with the pure article. Deteriorated drugs have been used in the same way. It goes without saying that these latter forms of adulteration cannot be detected by the microscope, although this instrument in connection with careful chemical tests may prove valuable.

MOUNTING POWDERS FOR EXAMINATION.

Powders for microscopical examination should be thoroughly mixed, so that the large and small particles will be uniformly distributed throughout the entire specimen, as before stated. In powders that have been standing for a considerable time the larger particles will be separated from the finer, so that great difficulty may be encountered in obtaining a typical mount from such a powder, unless it has been thoroughly mixed. Only a small portion of powder should be used in making a mount, the amount depending upon the size of the cover-slip to be used. When the mount is ready for examination, the particles should be spread out evenly and should not come in contact one with another so that the large ones might obscure the smaller.

Powders for examination may be mounted directly on the slide, using the proper medium, or the powder may be mixed with the mounting medium in a small test-tube, specimen tube, or homeopathic vial. If a small portion of powder be transferred to a slide, a drop of the desired mounting medium added, and the whole thoroughly mixed and covered with a cover-slip, it will furnish a mount ready for examination. However, it is frequently desirable or even necessary to use some clearing agent in order to render dark colored or opaque powders transparent. In such cases the powder should be thoroughly mixed with the reagent and left standing for twelve hours or more, when a portion may be taken up with a pipette and a drop of the mixture transferred to a slide.

Clearing Agents and Mounting Media.—For making temporary mounts of powders water is the best general medium, and should be used whenever a clearing agent is not required. In this medium delicate markings are clearly brought out, and it is especially recommended for the examination of starches. Frequently specimens are filled with air, which

must be removed before a satisfactory examination can be made. For driving out air 70 per cent. or stronger alcohol should be used, but this is not a desirable medium for general use, as it evaporates rapidly and allows the specimens to dry up. However, this medium is excellent for bringing out details of structure, and may be profitably employed when a hasty examination is to be made. It can be replaced by water or other media as desired.

Equal parts of water and glycerine furnish one of the best and most useful mounting media. This mixture is especially desirable when delicate markings are not brought out in water. It acts as a clearing agent, and although the action is somewhat slow, it will render most specimens clear enough for examination. Equal parts of water, glycerine, and alcohol make a reagent to be preferred to the above in many respects, and is the most useful of the simple and cheap reagents. This mixture penetrates tissues well, acts as a clearing agent, and does not dry up. Specimens may be kept in it for days or even weeks.

In the examination of many specimens it is necessary to use a strong clearing agent, and it is frequently desirable to have one that acts rapidly. Chloral hydrate, made by dissolving five parts of chloral hydrate crystals in two parts of water, is one of the most common and useful clearing agents. Its action is rapid, but it is not a good medium for mounting in many cases, since delicate markings are not clearly brought out by it. In many specimens starch is dissolved by this reagent, and it should never be used when accurate measurements of starch grains are to be made. However, chloral-hydrate solution with iodine added is the best and most reliable agent for the detection of starch, and is especially recommended where starch occurs in small quantities or is likely to be obscured, as in chloroplasts or by proteid substances.

A clearing agent to be preferred to the above for general purposes may be made by mixing 1 part of 95 per cent. alcohol, 1 part glycerine, 1 part water, and 4 parts saturated aqueous solution of chloral hydrate. This mixture gives a reagent fairly rapid in action, and also serves well as a mounting medium. It is the most useful clearing agent and can be employed in more cases than any other.

Potassium hydrate in 2 to 10 per cent. aqueous solution is valuable as a clearing agent, and also serves well as a macerating agent. It is rapid in action, and dissolves starch. Acetic acid, 20 per cent., and hydrochloric acid, 10 to 20 per cent., may be found exceedingly useful as clearing agents in many cases. They are often valuable in removing starch from specimens where it may interfere in an examination.

In the preparation of specimens which are exceedingly difficult to clear, or in handling coarse powders where the fragments are so large that they

must be broken up by macerating before mounting, javelle water and Schultz's macerating fluid will be found useful.

The action of any of the clearing agents mentioned above may be hastened or increased by the application of heat. By holding a mounted specimen over the flame of an alcohol lamp or a Bunsen burner it can be heated without injury, even to boiling, if proper care be exercised.

For more detailed directions for the use of reagents see Chapter IX, on Reagents and Processes, where a complete list of reagents is discussed

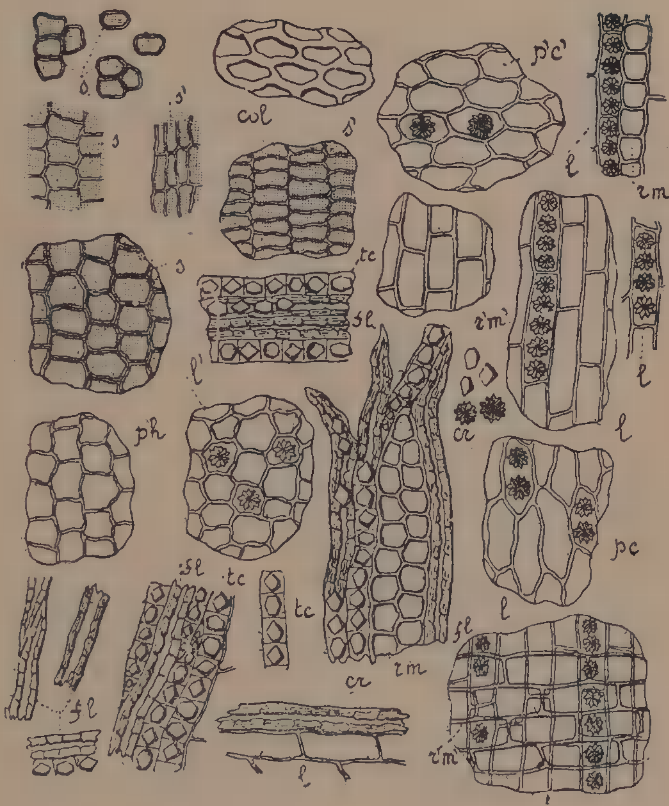

FIG. 360.—Powdered *Rhamnus Frangula*—Bark. (× 210.) *col*, Collenchyma of the cortex. *cr*, Prismatic and rosette crystals. *fl*, Bast fibers with pitted walls. *l*, *l′*, Bast in longitudinal and transverse section. *pc*, *p′c′*, Cortical parenchyma, in longitudinal and transverse section. *ph*, Phelloderm. *rm*, *r′m′*, Medullary ray in tangential and radial section. *s*, *s′*, Cork in tangential and transverse section. *tc*, Rows of crystal cells.—(*From Greenish and Collin.*)

and explicit directions given for their use. This list of reagents is arranged alphabetically and is in convenient form for handy reference.

Measurements.—The fragments of powders should be carefully measured, and the measurements used for comparison wherever it is possible to do so. Measurements should be made with an eye-piece micrometer. In preparing specimens for measurement the greatest care should be exercised in the use of reagents so that objects may not be swollen abnormally or distorted before measurements are made.

On the following pages are given a few examples to show the diagnostic characteristics of some powders which frequently, either by mistake or intentionally, are substituted one for the other.

The first example is illustrated by the barks taken from the same genus—Frangula, Fig. 360, and Cascara sagrada, Fig. 361. A comparison of the fragments composing these two powders shows them to be very similar in structure. Cascara presents one striking difference, as shown by the

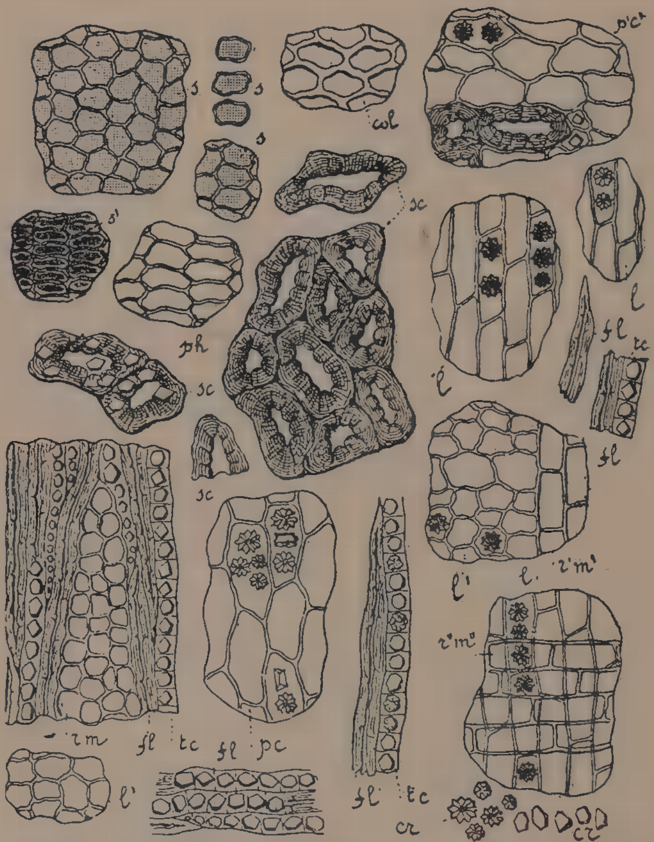

FIG. 361.—Powdered Cascara Sagrada Bark (*Rhamnus Purshiana*). (× 210.) *col*, Collenchyma of the cortex. *cr*, Prismatic and rosette crystals. *fl*, Bast fibers. *l*, *l'*, Bast in longitudinal and transverse section. *pc*, *p'c'*, Cortical parenchyma in longitudinal and transverse section. *ph*, Phelloderm. *rm*, Medullary rays, tangential section. *r'm'*, The same, transverse section. *r''m''*, The same, radial section. *s*, *s'*, Cork, in surface view and section. *sc*, Sclerenchymatous cells. *tc*, Rows of crystal cells.—(*From Greenish and Collin.*)

sclerenchymatous cells, *sc*, Fig. 361, which occur quite commonly, but occur rarely, if ever, in Frangula. In each of the specimens are bast fibers, but in Frangula the fibers have thicker walls and contain more numerous and well-defined pits than do the fibers of Cascara. Also the cork cells and the large parenchyma cells of the cortex show characteristics which are of diagnostic value. In Frangula the cork cells contain a deep red or purplish coloring substance, while those of Cascara have a reddish-

brown coloring substance. In the large parenchyma cells of Cascara is found a substance yellowish in color which changes to orange upon the addition of potassium-hydrate solution, while in Frangula the large parenchyma cells contain a coloring substance of a much brighter yellow, which upon the addition of potassium-hydrate solution changes to a red or deep purplish color.

The second example is illustrated by two roots taken from closely related species—Brazilian Ipecac, Fig. 362; Psychotria Ipecacuanha (Stokes)

FIG. 362.—Powdered Ipecacuanha Root (*Cephælis ipecacuanha*). (× 210.) *a*, *a'*, *a''*, Starch grains, simple and compound. *ccr*, Cells with calcium oxalate. *fl*, Fibrous cells. *l*, Bast. *pc*, *p'c'*, Cortical parenchyma in longitudinal and transverse section. *ph*, *p'h'*, Phelloderm in surface view and section. *ra*, Raphides. *s*, *s'*, Cork in surface view and profile. *tra*, Tracheids.—(*From Greenish and Collin.*)

of the British Pharmacopœia; Cephælis Ipecacuanha (A. Richard) of the U. S. P.; and undulated Ipecac (Fig. 363), which represents species from several different genera, such as Richardsonia, Psychotria, Ionidium, etc. The starch grains from each specimen are similar in form and structure, the only difference being that the starch grains from Brazilian Ipecac, ranging in size from 4 to 15 microns, are uniformly smaller than are those of undulated Ipecac. The elements of the xylem, however, furnish a ready and reliable means of distinguishing between these two powders.

The xylem of Brazilian Ipecac consists of tracheids, *tra*, Fig. 362; and of peculiar strongly pitted wood parenchyma, which somewhat resembles tracheids, *fl*, Fig. 362. Undulated Ipecac shows the presence of strongly pitted water tubes (pitted vessels), *v*, Fig. 363, and quite typical wood fibers, *fl*, Fig. 363. Brazilian Ipecac does not show water tubes, unless fragments of the stems become mixed with the roots.

As a third example, the leaves of Belladonna, Fig. 364, and Hyoscyamus, Fig. 365, furnish an excellent illustration. The epidermal cells of Bella-

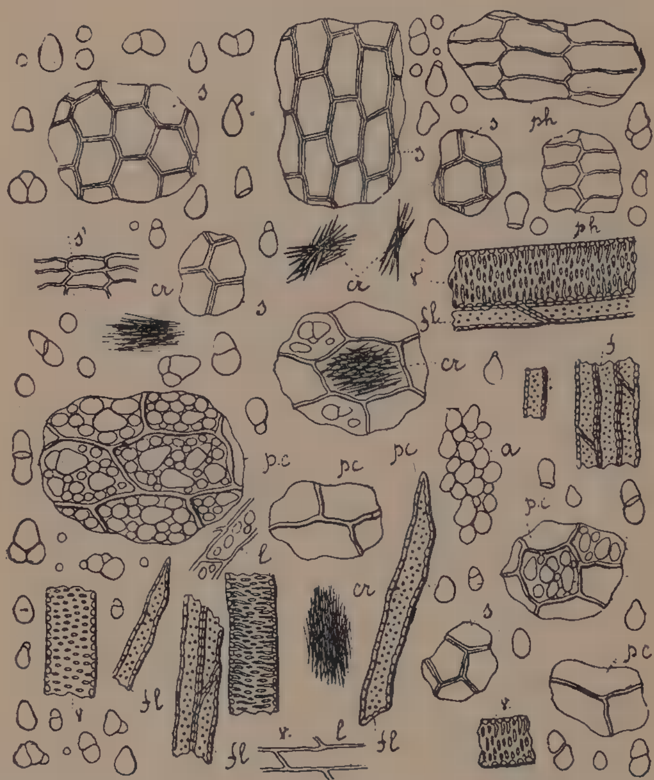

FIG. 363.—Powdered Undulated Ipecacuanha. (× 210.) *a*, Starch grains. *cr*, Acicular crystals. *fl*, Pitted wood fibers. *l*, Bast. *pc*, Cortical parenchyma. *ph*, Phelloderm. *s*, *s'*, Cork, in surface view and section. *v*, Pitted vessels.—(*From Greenish and Collin.*)

donna are large with wavy walls and the cuticle is striated, *es*, Fig. 364; while Hyoscyamus has epidermal cells similar in every respect excepting the striated cuticle, *ei* and *es*, Fig. 365. The spongy parenchyma of Hyoscyamus contains numerous crystals of calcium oxalate, usually in the form of prisms, *cr*, *ccr*, Fig. 365; while Belladonna is without calcium oxalate excepting for crystal sand, which is contained in a few large cells of spongy parenchyma adjoining the palisade parenchyma,—*c*, *cr*, Fig. 364. The presence of prismatic crystals in Hyoscyamus is the most striking diagnostic character of these two powders.

The trichomes furnish other valuable diagnostic characters, but they are not always reliable, since Belladonna leaves that are almost glabrous, and consequently almost devoid of trichomes, are sometimes found. Either specimen may contain both simple and glandular hairs. The simple hairs are conical and may be composed of one or more cells. In Hyoscyamus the glandular heads, which may be either bicellular or multicellular, *pg*, Fig. 365, are borne on a stalk composed of two or more cells.

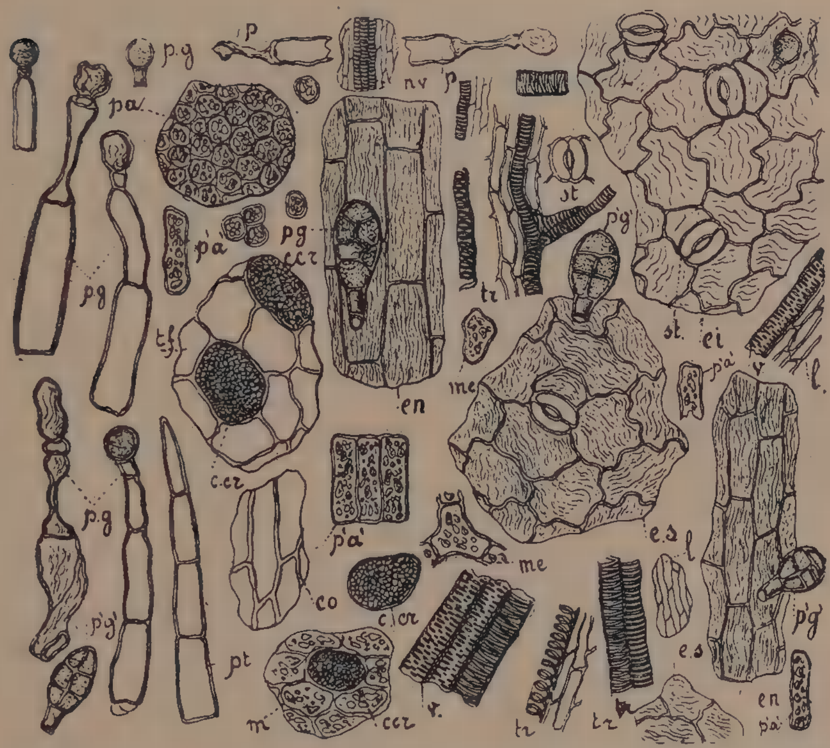

FIG. 364.—Powdered Belladonna Leaves. (× 210.) *c, cr*, Cells with sandy crystals. *co*, Collenchymatous cells from cortical tissues of midrib. *ei*, Epidermis of under surface. *en*, Epidermis over the veins, with striated cuticle. *es*, Epidermis of the upper surface, with striated cuticle and occasional stomata. *l*, Bast. *me*, Branching cells of spongy parenchyma. *nv*, Fragment of small vein. *pa* Palisade cells, surface view. *p'a'*, Palisade cells, in longitudinal section. *pg*, Glandular hairs, long and short, with unicellular and pluricellular glands. *st*, Stomata, surrounded by three or four cells, one of which is smaller than the others. *tf*, Cortical tissues of the midrib. *tr, v*, Tracheids and vessels. —(*After Greenish and Collin.*)

The glandular hairs of Belladonna are found with heads either unicellular or multicellular. The larger multicellular glands are usually borne on a stalk consisting of one or two cells, *pg*, Fig. 364, while the smaller ones are likely to have a stalk composed of several superimposed cells. The unicellular glands are rounded in form and are borne on stalks of several cells, *pg*, Fig. 364.

It should be stated that each drug has its own peculiar microscopical elements. Some of these, it is easy to see, are of special value in the identi-

fication of drug powders. In the general discussion of drugs (pages 78 to 487) the microscopical elements that we consider characteristic of the

FIG. 365.—Powdered Henbane Leaves (*Hyoscyamus niger*). (× 210.) *ccr*, Crystal cells. *cr*, Crystals of calcium oxalate. *ei*, Lower epidermis. *es*, Upper epidermis. *ffv*, Portion of fibrovascular bundle of midrib. *ip*, Scar of fallen hair. *m*, Spongy parenchyma. *pa*, *p'a'*, Palisade cells. *pg*, Glandular hairs. *pt*, Simple hairs. *st*, Stomata. *tf*, Cortical parenchyma of midrib. *tr*, Tracheid and vessels. —(*After Greenish and Collin.*)

drug powder are concisely stated in a separate paragraph under each official drug.

GENERAL DIRECTIONS.

As a general direction for the detection of adulteration or admixture, it cannot be too strongly emphasized, that authentic samples of the pure drug, and of the suspected adulterant or admixture, should be carefully studied, macroscopically and microscopically, as a preliminary process. This laboratory method supersedes all the aids in the form of representation by drawings and figures on paper.

FIG. 366.—Shows Starch-granules of Ipecac. The cells of the bark are filled with starch. The granules are spherical, oblong, or angular, and vary much in size. The hilum is located near the center, and is often seen to be fissured. The grains are smooth, and show no concentric markings. They are often in groups of two, three, and sometimes even more grains joined together.

FIG. 367.—Shows Starch-granules of Jalap. The grains are very numerous in the cells; are large and have characteristic markings. They are rounded or broadly ovate, having the hilum located near the small end and surrounded by excentric lines.

FIG. 368.—Shows the Starch-grains of *Veratrum viride*, which so closely resemble those of *Veratrum album* that it would be impossible to distinguish the two by their starch-grains. Those of the former are often found in groups of twos, threes, fours, and sometimes even more. They are small, rounded, or angular, with the hilum in the center.

FIG. 369.—Represents Starch as it appears in Calumba. The grains are large, and in shape they are circular or oval. A few double or compound grains are found, but they do not occur frequently. The hilum is rather excentric, and is often seen to be fissured in a radial direction. The grains are smooth, and occasionally a curved line or two is to be found.

FIG. 370.—Shows Starch-grains as they appear in Galengal. The grains are large and mostly long ovate, but sometimes they are irregular. The hilum is located near the larger end, and is sometimes fissured. The stratification lines are plainly seen on the larger grains and but faintly, if at all, on the smaller ones.

FIG. 371.—Illustrates Starch-grains as seen in a specimen of *Iris florentina*. These grains are quite characteristic and very abundant. They are rather elongated, rounded or truncate at one end, and usually tapering toward the other end. Occasionally a three-lobed grain is seen. As a rule, the grains are irregular in shape. The hilum is located near the large end, and is slightly fissured. (*a*) is the most common form. A very prominent characteristic is a double line branching from the hilum and extending toward the other end.

FIG. 366.

FIG. 367.

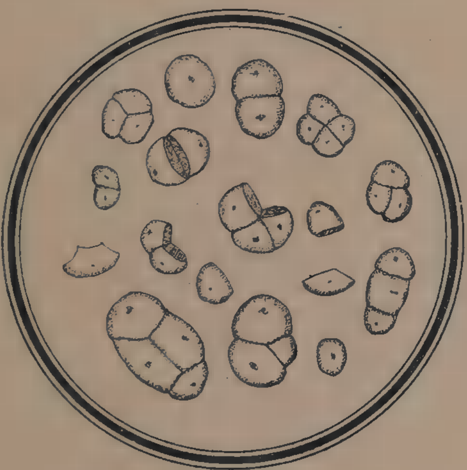

FIG. 368.

FIG. 369.

FIG. 370.

FIG. 371.

FIG. 372.—Shows Starch-grains as they appear in Caulophyllum. The grains are small, but quite characteristic. They are mostly gathered together in large and roundish masses, consisting of twenty-five to fifty grains. The single grains are globular, or more commonly many-sided, and without hilum or stratification lines.

FIG. 373.—Shows the Grains as they appear in *Aconitum napellus*. This drug is very rich in starch. The starch-grains are rather large. There are a great many compound grains composed of from two to eight granules. The single grains are round, long, and in some cases have flat faces. The hilum is located centrally, and is seen at times to be fissured slightly. The concentric markings are not discernible.

FIG. 374.—Shows Starch-grains as they appear in Geranium. There are specimens of Geranium in the market that contain little or no starch. This somewhat singular fact is said to be due to the season in which it is gathered. The drug usually contains starch in abundance. The grains are rather long, and appear to be thicker at one end than at the other. The hilum is located generally at the larger end, but sometimes central, and it occasionally appears at the smaller end. The stratification lines are very faintly seen at times.

FIG. 375.—Shows Starch-grains as they appear in Honduras Sarsaparilla. Many of the grains are seen to occur in groups of two, three, and sometimes four. The single grains are spherical or angular, with a hilum located near the center. The hilum in the larger grains is angular fissured. No concentric markings can be seen.

FIG. 376.—Shows Starch as it appears in Podophyllum. The grains are small and mostly single, but sometimes they are double or triple. They are spherical with a central hilum, and are seldom fissured. The hilum can hardly be seen in the smaller grains.

FIG. 377.—Shows Starch as it appears in the rhizome of Hydrastis. The starch is very abundant. The grains are most commonly joined together in groups of from two to six. The grains, when single, are rounded in form. The hilum is indistinct and unfissured.

NOTE.—The drawings of the starches were made from authentic specimens of the crude drug of the market. No fixed scale was used.

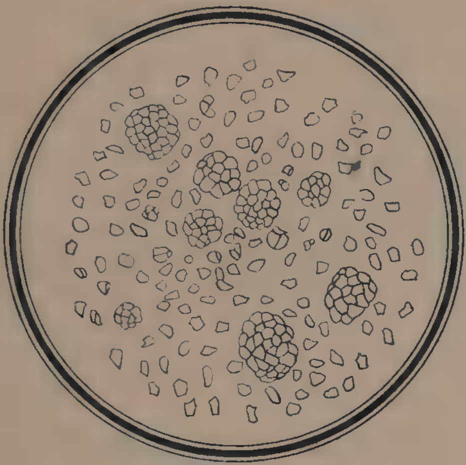

FIG. 372.

FIG. 373.

FIG. 374.

FIG. 375.

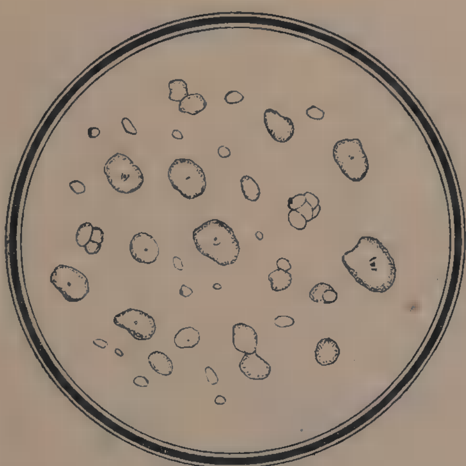

FIG. 376.

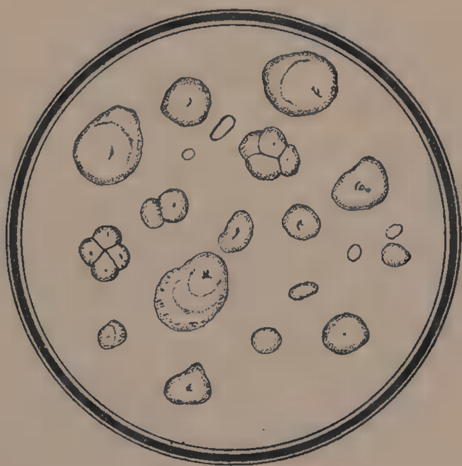

FIG. 377.

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Sayre, L. E.
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